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Technical Manual for the
**HANDLING, STORAGE AND MAINTENANCE OF
THE ARRAY STRUCTURE**

Installed on the
USNS MISSION CAPISTRANO (T-AG 162)

12 April 1963

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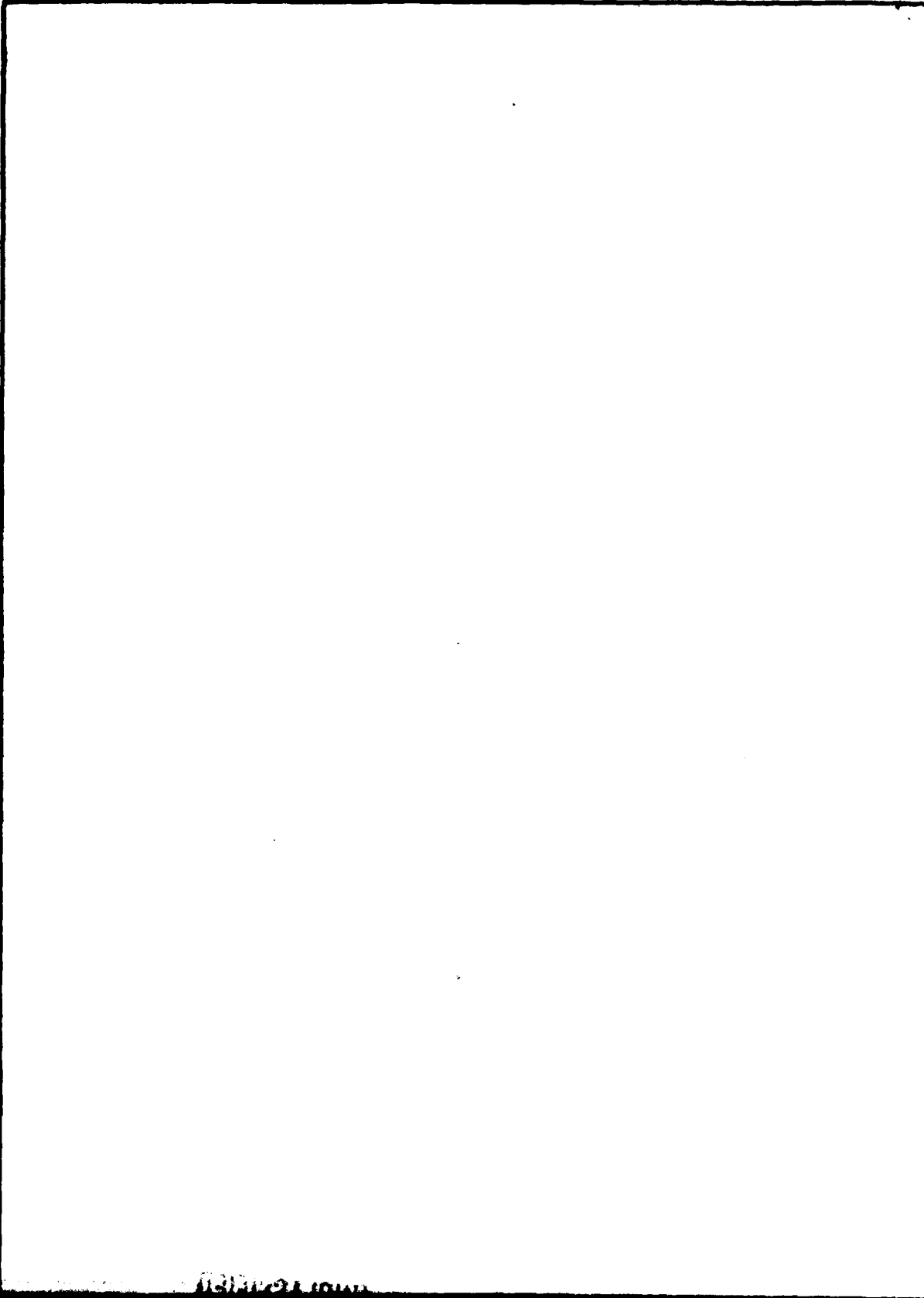
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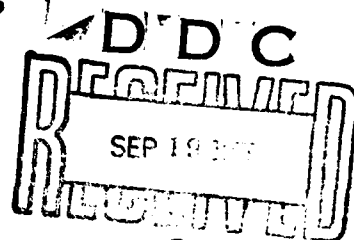
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CHAPTER I

GENERAL DESCRIPTION OF THE ARRAY HANDLING SYSTEM

I-A INTENT OF THE MANUAL

The intent of this manual is to describe the equipment and operational procedures that will be employed in lowering, hoisting, securing for transportation, and maintaining an assembly herein referred to as the array, during the mobile operations of Project ARTEMIS.

The basic units and their functions are briefly described in this chapter. The complete description, with the sequence of operation, is contained in the subsequent chapters of the manual.

I-B VESSEL (Fig. I-1)

The USNS MISSION CAPISTRANO (T-AG 162) is a self-propelled vessel specifically designed for this operation. It carries aboard the necessary equipment and gear for lowering, hoisting, and housing the array. Other equipment in way of generators, amplifiers, electronic gear, etc., is installed to make the vessel a self-contained unit for the intended operation. It is not the purpose of this manual to describe the operation or functions of equipment other than that used for the array handling.

The principal characteristics of the vessel are:

Length between perpendiculars	503 ft. - 0 in.
Length overall	523 ft. - 6 in.
Beam	68 ft. - 0 in.
Depth	39 ft. - 3 in.
Operational draft	26 ft. - 0 in.

The approximate displacement of the vessel at operational draft in salt water is 18,550 long tons.

I-C RESTRICTIONS BY SEA STATE AND WEATHER FORECASTS

It is within the discretion of the Commanding Officer and the Office of Naval Research Project Representative to exercise their judgment on the sea state and conditions which will permit

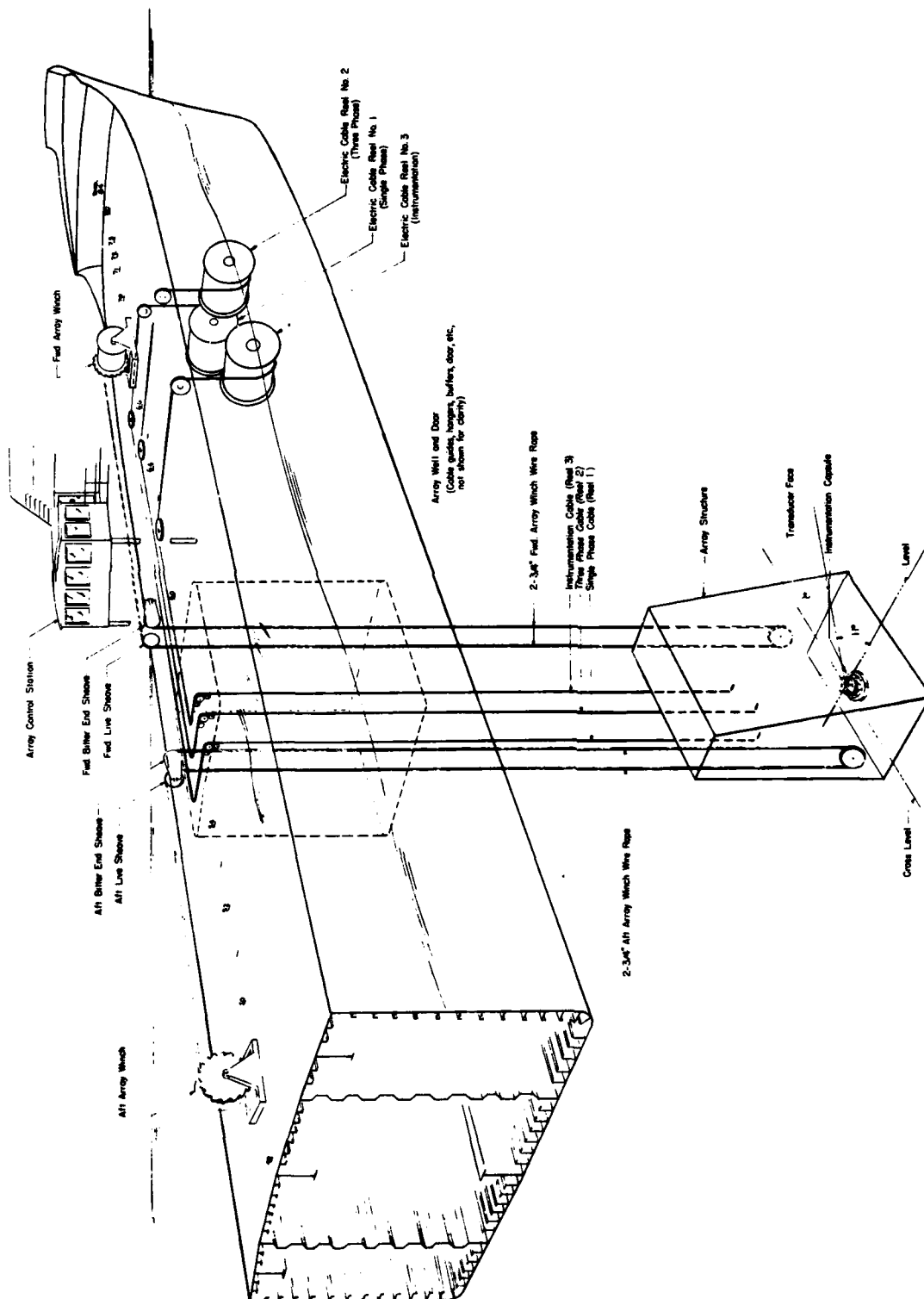


Fig. I-1 - Composite arrangement hull, array winches and electric cable reels array suspended

a satisfactory lowering and hoisting of the array without endangering the ship or project equipment. From a detailed study of the vessel's motions in roll, pitch, and heave, under various sea conditions and from operating experience, the establishment of the limitation for roll is eight (8) degrees from upright, and the limitation for pitch is one and one-half (1-1/2) degrees from the trim condition. Under certain conditions after the array has been lowered, it may be necessary to hold the array in a suspended condition until the sea state will allow a satisfactory recovery.

Weather reports of pending conditions should be maintained on a continuing basis for at least twenty-four hours prior to contemplated operation. Weather reports are to be obtained from several stations, in addition to the local watch.

Operation limitations are discussed in detail in Chapter II.

I-D ARRAY WELL AND DOOR (Fig. I-2)

The array well is located approximately amidships in the vessel astride the fore and aft centerline. The opening in the deck is 48 feet, 1 inch, fore and aft between frames 55 and 59. The width is 30 feet, 9 inches, athwartship.

The fore and aft bulkheads of the array well are outfitted with guide arrangements to match with guide shoes on the array, a hanger system to support the array in transport, and guides for controlling the supporting wire rope load imposed by the array in the lowering and hoisting operation.

The port array well bulkhead is outfitted with three electric cable guide devices. The electric cables each terminate on the array and are necessarily payed out and retrieved at approximately the same rate as the travel of the array in the lowering and hoisting operation.

The supporting structure for the array wire rope sheaves are constructed over the fore and aft array well bulkheads. Each structure supports one "live" sheave and one bitter end sheave which serves as a tie-down and tension indicator. The array is therefore supported by four parts of 2-3/4 inch diameter wire rope, two forward and two aft.

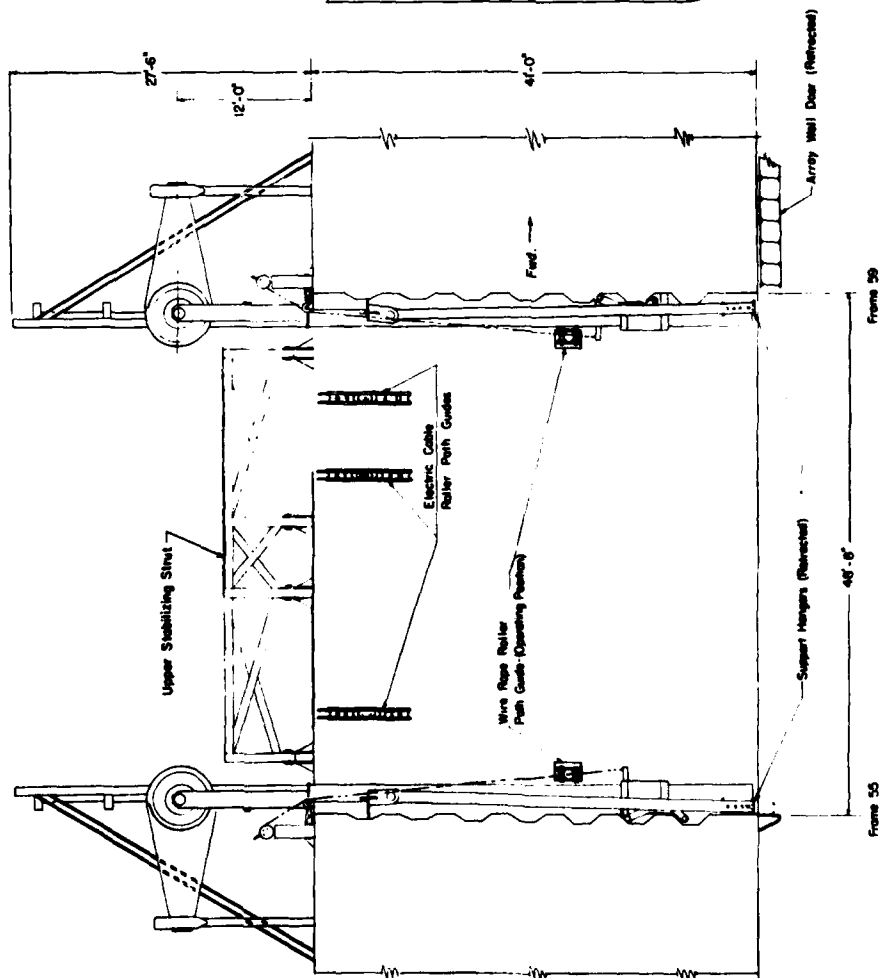
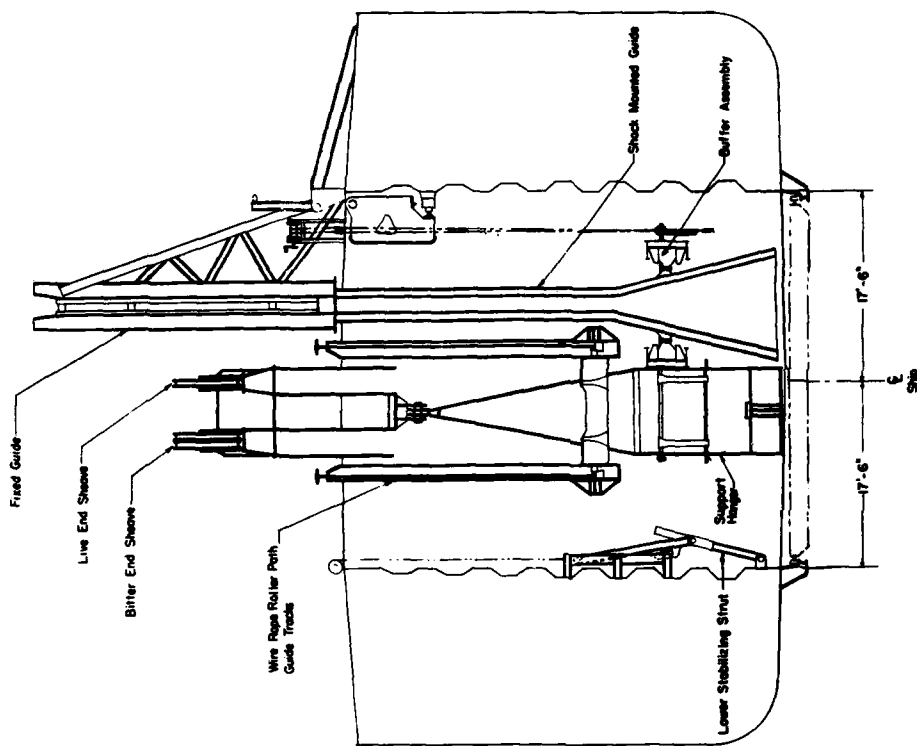


Fig. I-2 - Array well

The guide devices previously mentioned extend 27 feet above the deck at the fore and aft array well bulkheads to provide stability to the array when raised to a height suitable for maintenance.

The array well door is under the bottom of the vessel and is supported on rollers that nest in tracks parallel and adjacent to the port and starboard array well bulkheads and extend forward a sufficient distance to allow full opening. Locking pins and stops are provided to sustain the door in either fully opened or fully closed positions. A system of sheaves and wire rope control the opening and closing of the door from the main deck. The door is closed at all times that the array is stowed and the vessel is under way. The door is open when the operation of lowering and hoisting the array is being conducted and also when the array is raised to positions above the stowed elevation for maintenance. Heavy or fouling objects that are accidentally dropped in the well could cause damage to the door and/or the vessel if the door were to remain closed during maintenance.

I-E THE ARRAY (Fig. I-3)

Of particular interest to the operations of handling the array is the instrumentation capsule which is mounted on the base structure of the array. This capsule houses the instruments that transmit to the surface the following information on the attitude and behavior of the submerged array structure:

Depth below surface,

True bearing (North) of the transducer face of the array,

Cross level (corresponds to longitudinal trim of ship with array in stowed position), and

Level (corresponds to athwartship trim of ship with array in stowed position).

NOTE: Level refers to the base of the array structure; however, it is to be noted that the transducer face is at an angle of eleven (11) degrees to the base.

Two sheaves for the four parts of 2-3/4 inch diameter wire rope, mounted transversely in yokes hinged from the base structure fore and aft, have their respective grooves to line up with the "live" and bitter-end sheaves, as outlined in I-D.

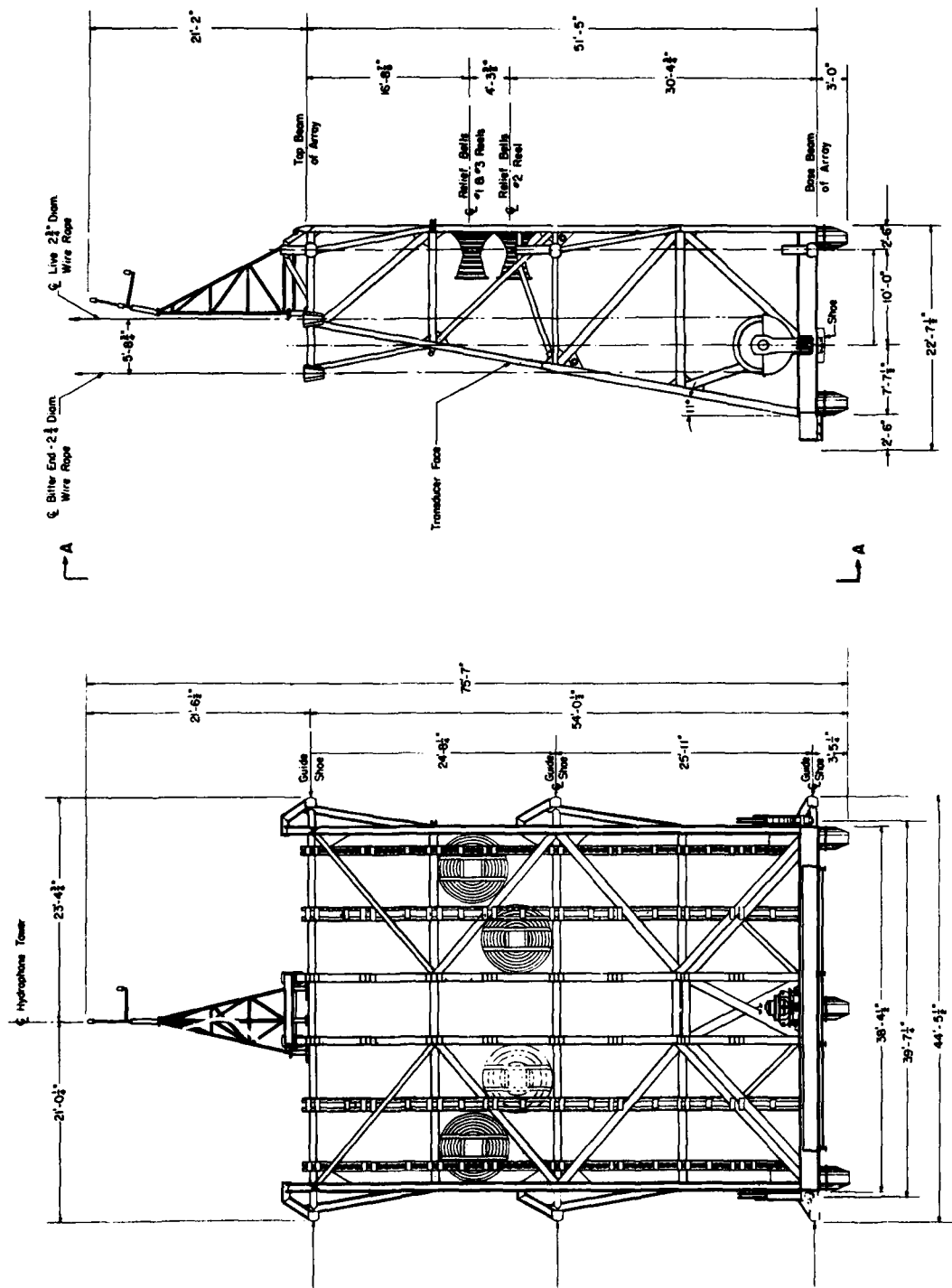


Fig. I-3 - Array structure

Stability of the array is attained by six guide shoes, three fore and three aft, that operate within the array well guides (outlined in I-D) during the phases of operation that the array is in the confines of the array well. Four rope guide sleeves, two fore and two aft, are attached to the topmost main structure of the array to maintain stability when the array is suspended beyond the scope of the array well guide devices.

A hydrophone tower, equipped with a position determination system or current indicator for direction and velocity of water, is mounted on the uppermost structure of the array. The tower is of interest in this manual only in that its peak fittings are visible for reference by observers when the array lowers below the waterline or emerges for re-entry into the array well.

I-F ARRAY WINCHES

Two array winches for supplying hoisting power to the 2-3/4 inch diameter wire rope that supports the array are located on the main deck, one forward of the array well and one aft of the array well. The array winches have electrohydraulic drives and both are remotely controlled by a single operator at the array control station.

I-G ELECTRIC CABLE REELS

Three electric cable reels are located below deck forward of the array well. Each reel is assigned to pay-out or heave-in its respective double-armored submarine electric cable through a system of guide devices at a rate that follows the array during the lowering and hoisting operation. Three operators are required (one for each reel) at the master controllers in the array control station.

The reel assignments are as follows:

Reel #1	Single-phase power cable.
Reel #2	Three-phase power cable.
Reel #3	Multi-conductor instrumentation cable.

I-H ARRAY CONTROL STATION

The array control station is located forward and above the array well so that the operations can be observed and supervised from a vantage point.

Controls for operating the two array winches, the three electric cable reels, and the array instrumentation are mounted within the station with their respective consoles.

The array winch console is made up of the following metering and indicating devices:

- Winch drive motor tachometer (one fore and one aft),
- Differential tachometer (indicates difference in fore and aft motor speeds),
- Hoist or lowering speed in feet per minute,
- Footage from stowed position in total feet and tenths of a foot,
- Tension in pounds in the 2-3/4 inch diameter wire rope (also continuously recorded on chart), and
- Indicator lights:
 - a. Power "On" lights, and
 - b. Brake "Engaged" (red), and brake "Disengaged" (green).

Each electric cable reel controller has its respective console made up of the following metering and indicating devices:

- Cable payed out at the array well, in total feet,
- Cable payed out at the reel, in total feet,
- Tension at the array well, in pounds,
- Tension at the reel, in pounds converted from motor wattage,
- Indicator lights to indicate status of "Power", and limit of travel of the fleeting sheaves, and
- Selector switch to operate in "Speed" or "Tension".

The array instrumentation console, located forward of and alongside the number 3 electric cable control, is the master unit for

azimuth, level, and cross level readings read at the array control console. In addition to these instruments is the nitrogen pressure system which equalizes the hydrostatic pressure on the modules. An instrumentation operator is continuously monitoring this system during the lowering and hoisting operations.

I-J 30-TON BOOM (Fig. I-4)

A kingpost is mounted 12 feet aft of the aft array well bulkhead, and in line with the starboard array well bulkhead. The kingpost is outfitted with rigging and a 63 foot boom to service the array well area. A hoisting winch is provided to supply hoisting power to the load hook, and a topping winch is provided to supply power for raising and lowering the boom. Both of these winches are located on the main deck aft of the array well bulkhead and approximately 12 feet to port of the ship centerline. A vang winch with one port, one starboard, and one centerline vang post with related gear, is provided to swing the boom in a radius around the kingpost. Controllers for all components are grouped on deck immediately outboard of the kingpost. All winches for the 30-ton boom are direct current and power is supplied by the 500 kilowatt direct current diesel generator in the gas turbine room. Thirty minutes' notice to light-off this generator should be given the Engineering department. The 30-ton boom, aside from being used for loading and off-loading materials required in the operation, is also used for servicing the array during maintenance.

I-K HYDROPHONE BOOM

On the face of the array structure there is space for mounting a 50 foot frame structure boom which supports acoustic monitoring equipment. This boom is pushed away from structure after structure is lowered to 65 feet. A cylinder and piston arrangement, connected to structure and boom, is charged with carbon dioxide forcing piston outward to where boom falls free to an angle of about 55 degrees from face of structure. A retrieving line is secured to the boom with the bitter end of line secured to one of the electric cables. When array is hoisted to 65 feet, the bitter end of line is removed from electric cable and boom is pulled in against face of structure and secured. Hoisting of array may continue after boom is secured. Normally, when hydrophone boom is to be installed, the structure will be raised as listed in section V-M-9.

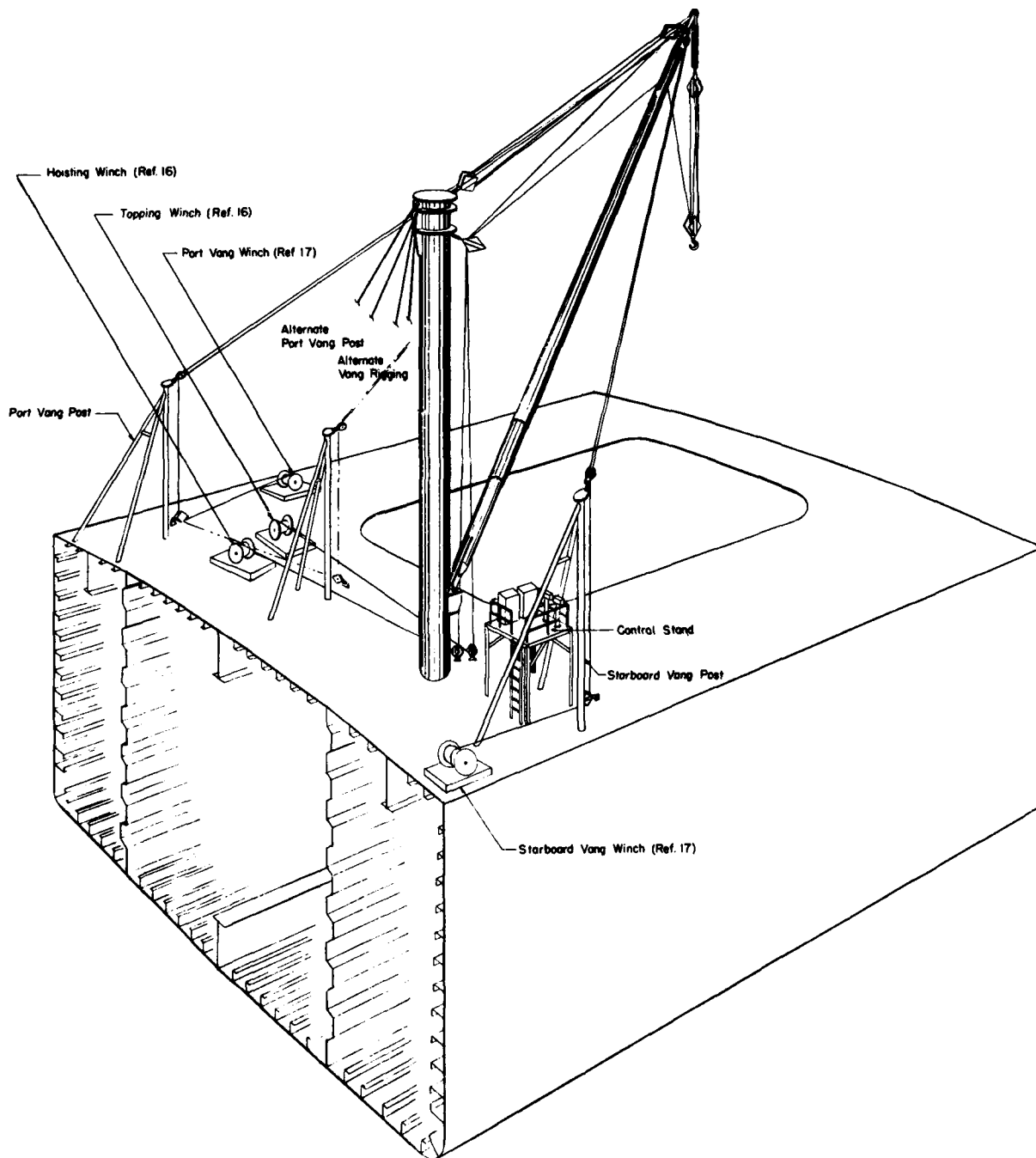


Fig. I-4 - 30 ton boom arrangement

I-L BOW THRUSTER

- I-L-1** A bow thruster is provided to maintain ship's heading so that projector can be trained in any direction and this heading maintained.
- I-L-2** Installed in bow of ship frame 95 and four feet, 3-1/2 inches, above keel is a 500 horsepower bow thruster. The thruster has movable blades whose pitch is adjustable through hydraulic-operated control equipment. Primary control for thruster is pneumatic and is located in array control room; along with control stand, there is mounted an indicating panel which provides for starting and stopping the vent fan, hydraulic pump and prime mover. The panel indicates availability for operation, normal operation after starting and sounds an audible alarm for low air pressure, low hydraulic pressure or high main motor temperature. An ammeter is provided to indicate motor load and the direction of control is indicated by three lights, "Steer Right", "Midship" and "Steer Left".
- I-L-3** An instruction book is provided for further detailed operations and maintenance of the bow thruster.

I-M COMMUNICATIONS

A sound-powered telephone system is installed with stations at the several control points to aid in coordinating all phases of the operation. The control points are listed in Chapter III.

I-N SAFETY

Every effort has been expended in the design of this handling system to provide the ultimate in safety features for the protection of personnel and equipment. However, the unusual scope and features of the installation require prudence of everyone engaged in the operations to see that the standards of safety are observed.

Safety precautions are noted throughout the manual where they are pertinent. Because some are inadvertently omitted, the personnel are nonetheless expected to maintain the usual standards. Whenever and wherever conditions exist that are hazardous, they should be brought to the attention of the ONR Project Representative so that corrective measures can be taken.

REMEMBER: ACCIDENTS DON'T HAPPEN; THEY ARE CAUSED.

CHAPTER II

DISCUSSIONS OF AT SEA CONDITIONS THAT INFLUENCE HOISTING, LOWERING, SUSPENDED CONDITION AND DEPTH

The material contained in this chapter of the manual is presented as a guide to those charged with the responsibility of lowering and raising the array. Normally the vessel lying dead in the water without steerage or propulsion will head so that the wind and seas will approach the vessel from a bearing of five to 15 degrees abaft the beam. This direction of seas will reduce the heave and pitch to a minimum and will cause the vessel to roll in the seaway. Due to the configuration of the array structure and the electric cables, it is deemed advisable to head the vessel so that the wind will be on the port side during lowering and raising operations. This position is recommended since it is assumed that the vessel will drift to starboard and that the drag of the array structure below the surface will cause it to seek a position under the vessel to port of the centerline. This position will tend the electric cables away from the array structure and reduce the chances of the cables fouling the structure.

Since the vessel is adrift, it is assumed in this chapter that the drifting speed of the vessel will be greater than the below surface currents. Should the below surface currents be of a magnitude and direction contrary to the above assumption, precautions based upon experienced seamanship will have to dictate. An idea of the below surface currents may be obtained by the observations of the level and azimuth readings relayed to the surface from the instrumentation capsule.

The array guides and guide shoes have been designed for raising and lowering the array structure when the vessel is rolling at a maximum angle of eight degrees to port and eight degrees to starboard and pitching at a maximum angle of $1\frac{1}{2}$ degrees. It is anticipated that these operations will be limited to the above criteria. When the array is secured in the vessel or lowered clear of the well, other magnitudes of heaving, pitching or rolling may be experienced and no attempt should be made to lower from the well or raise the array into the well until the ship motions are within the above limitations.

The bow thruster can be used to maintain heading as desired while lowering or hoisting to reduce roll and pitch.

Inclinometers to measure the angles of trim and list are installed on the forward bulkhead of the array control station.

II-A ELECTRIC CABLE TENSION

II-A-1 Electric Cable Tensions at Array Well (Refer to Section III-A-4-c)

The tensions measured at the array well are to be corrected by the factor shown on the curve (figure II-1). The exact tension reading on the indicators in the array control station occur only when the cables are hanging parallel to the centerline plane of the vessel. If the cable tends to starboard, the actual tension is less than the indicator reading, and, if the cables tend to port, the actual tension is greater than the indicator reading. Thus, the readings vary with the athwartship angle of suspension.

II-A-2 Cable Tension

At "zero" knots current, the tensions are directly equal to the length of cable payed out. The tension will increase due to horizontal drag forces resulting from current past the cables, by translatory ocean waves and by dynamic loads resulting from the ship heaving in the seaway. These forces are within the capability of the system when operating with the ship lying to in the ocean.

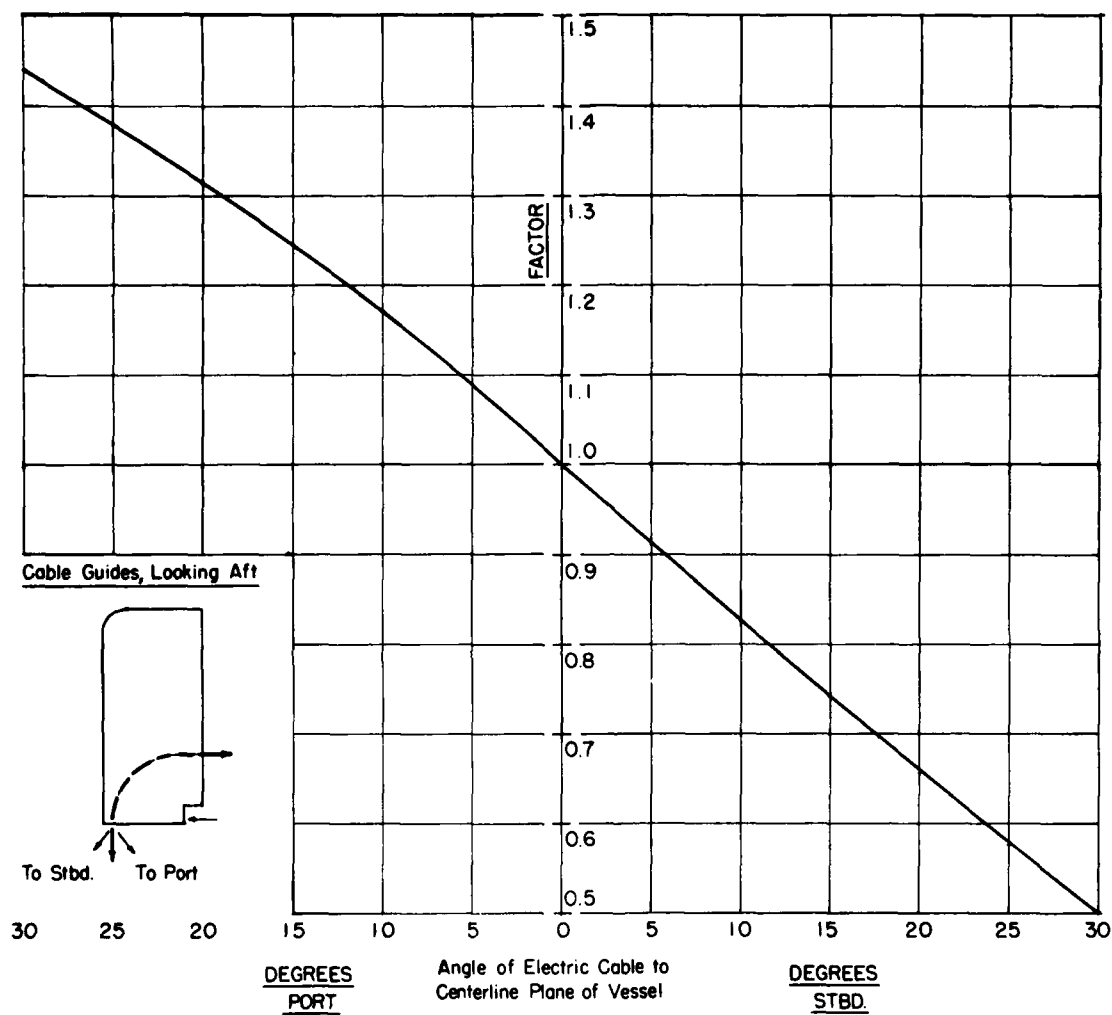


Fig. II-1 - Curve for correction factor to be applied
to cable tension indicator

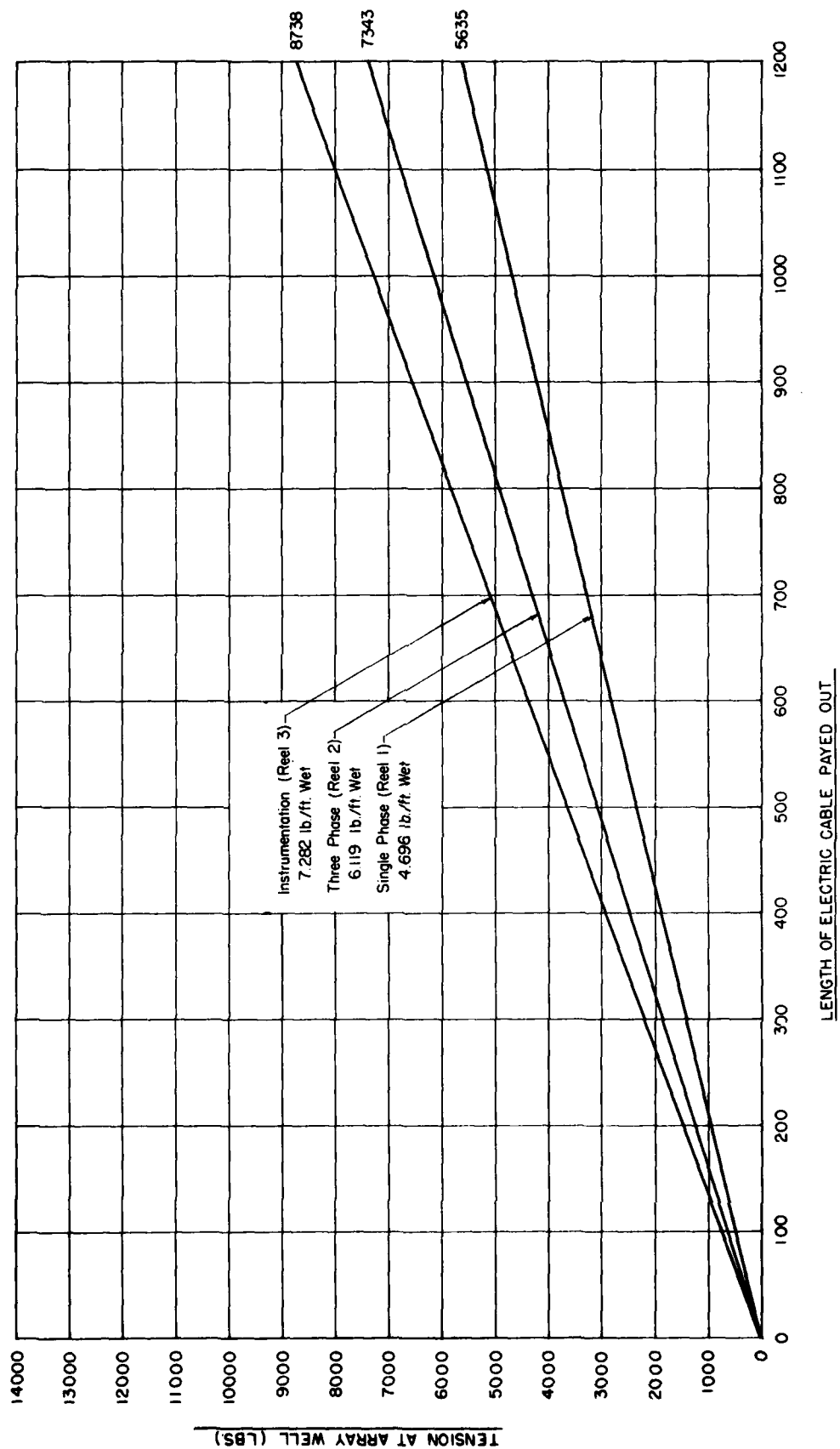


Fig. II-1A - Electric cable tensions at array well
 for "zero" knots current

CHAPTER III

CONTROLS, INDICATORS, SAFETY AND INTERLOCK FEATURES

III-A ARRAY CONTROL STATION

The array control station is mounted on an elevated platform 17 feet above the main deck on the longitudinal centerline and extends from 12 feet forward of the forward array well bulkhead to the bridge deck. The control room enclosure is outfitted with windows along the port and starboard sides, and along the transverse face overlooking the array well area. All controls and instrumentation for operating the fore and aft array winches, the three electric cables reels, and the bow thruster are in the shelter of the station. From this station the supervisor controls the sequence of lowering and raising operations both on the deck around the array well, and in the control station. The supervisor is in contact, by sound-powered telephone, with the following stations throughout the ship:

1. Amplifier console.
2. Generator control room.
3. Project control center.
4. Master's stateroom.
5. Pilot house.
6. Technician's mess.
7. Bow control.
8. Array control station.
9. Chief engineer's stateroom.
10. Engine room.
11. High voltage switchgear room.
12. Forward reel room.
13. Aft reel room.
14. Bow thruster machinery room.

The array control station supervisor, the array winch operator, three electric cable reel operators, and instrumentation operator comprise the normal complement of the control station during the lowering and raising operation.

III-A-1 Array Winch Control

The fore and aft controllers are mounted on a single pedestal to starboard of ship centerline. The operator stands facing to starboard with his left hand to operate the forward array winch and his right hand to operate the aft array winch. Position of the levers, other than neutral are maintained without external force. Cam-actuated limit switches installed within the stroke centering device at the winches serve as a lock-out feature that will not permit the motors to be started unless the pumps are in the neutral position. The control levers in the control stations are mechanically connected by a system of wire rope pulleys and roller chain to the stroke control at its respective winch. By pulling the levers from vertical inboard, the operator raises the array structure, and, by pushing the levers outboard, the operator lowers the array structure. The control levers have offset knobs to enable the operator to maintain lever position by spanning the knobs with either hand. The electro-hydraulic winch drive affords infinite selection from the neutral (brake applied) position to the maximum speed. Two "power-on" indicator lights are provided, one for the forward array winch and one for the aft array winch. On the sides of the pedestal, facing their respective fore and aft array winches, "start", "stop", and "emergency run" buttons are mounted for the array winch pump motors. (For further description, see manual, "Electro-Hydraulic Array Winch", reference 14.)

NOTE: The "emergency run" pushbuttons are provided to allow the operator to bypass overloads in the event that stopping the array winches would jeopardize the operation. Corrective measures to re-instate overload protection should be undertaken at once.

III-A-2 Array Winch Console

The array winch operator faces an instrument console mounted behind and over the controller pedestal. The console houses the metering instruments and indicators necessary to him in his operation (figure III-1). Figure III-2 illustrates the schematic electrical block diagram of the array winch system.

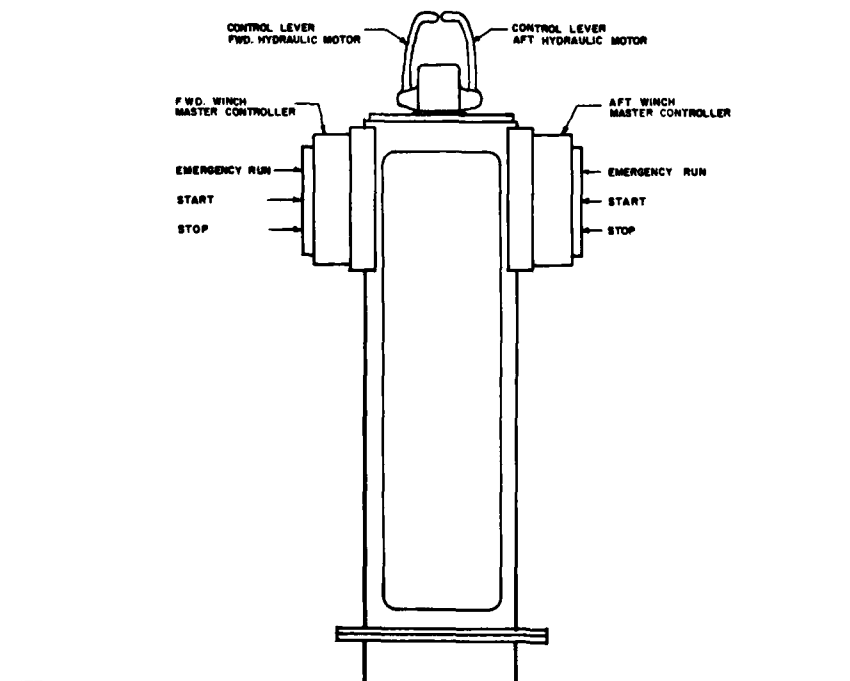
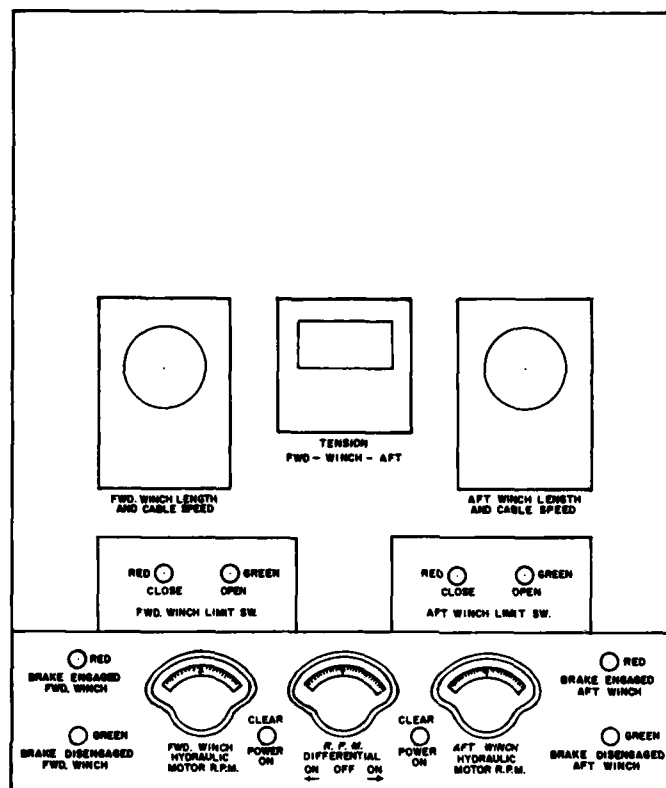


Fig. III-1 - Array winch, master controller arrangement at array control station

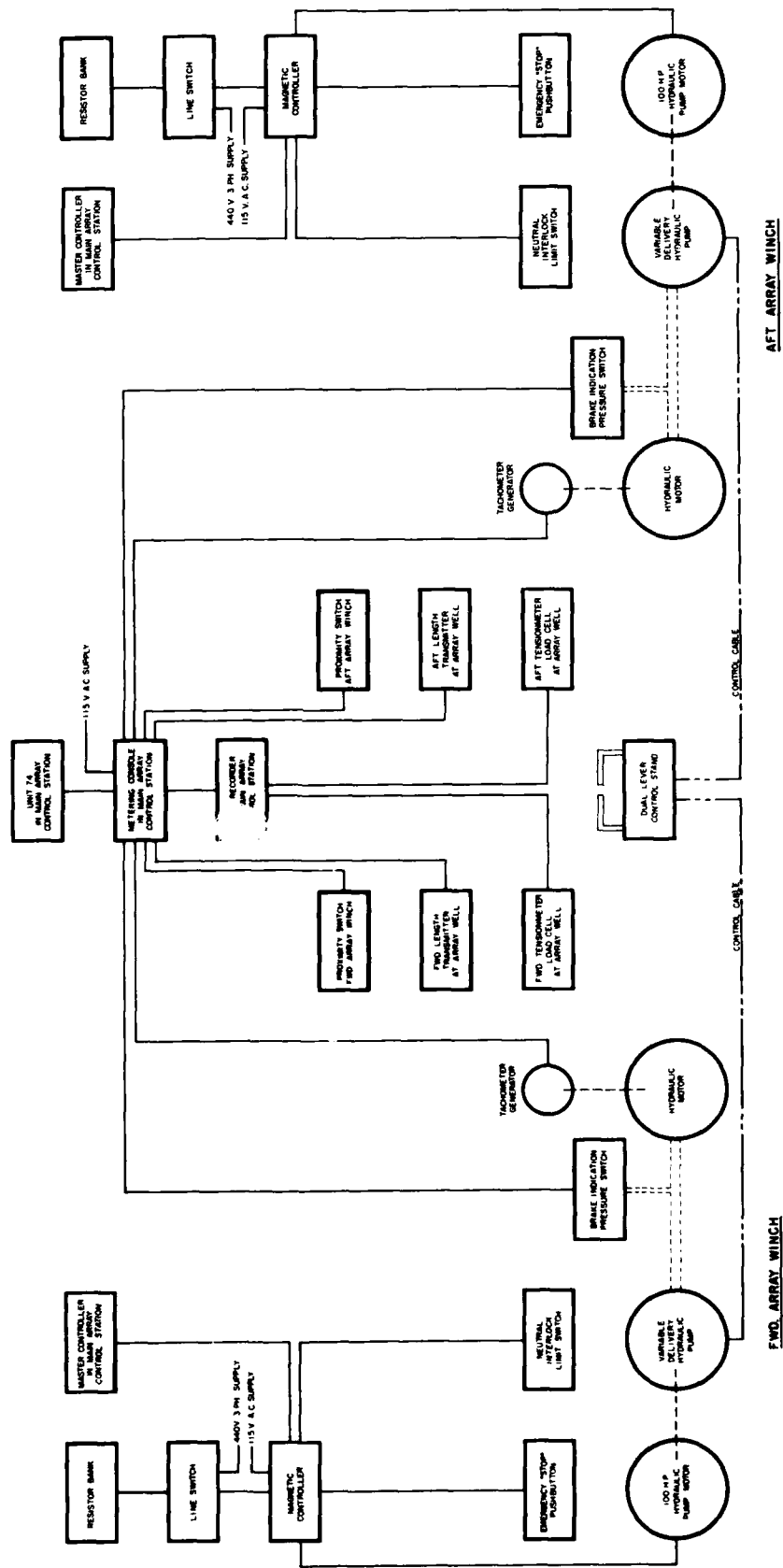


Fig. III-2 - Electrical block diagram, array winches

The meter and indicators, with their respective functions, are herewith listed:

III-A-2-a Length Indicator and Cable Speed Indicator

Two meters are provided to indicate the depth and rate of change of depth by the operation of their respective array winch drums. The length indicators (footage counters) are adjusted to "zero" reading with the array structure in the stowed position. Positive readings indicate the amount in feet that the array has been lowered below the stowed position. Negative readings indicate the amount in feet that the array has been raised above the stowed position. The rate of change of depth corresponding to the operation of the fore and aft array winches is indicated to aid the operator in maintaining uniform coordinated operation of the fore and aft array winches, which, in turn, assists in maintaining the array within the limits of cross level. This rate of change of depth (speed) is indicated for both raising and lowering. (This speed indicator is supplemented by a differential tachometer for greater sensitivity as described in III-A-2-b.)

III-A-2-b Tachometers and Differential Tachometers

Two tachometers are provided: one to indicate the rpm of the forward array winch hydraulic motor, and the other to indicate the rpm of the aft array winch hydraulic motor. Readings to the left of "zero" indicate hoist speed, and readings to the right of "zero" indicate lower speeds. The tachometers indicate rpm from "zero" to 1200 in either direction. Interconnected with the two tachometers is a differential tachometer that indicates the difference in motor speeds of the fore and aft array winch motors. Differentials up to 200 rpm are indicated. (Differentials in excess of 200 rpm are not injurious to the meter.) A two-position selector switch is provided for assignment of the reading of the differential tachometer; one position

for hoist and the other for lower. Readings to the left of "zero" indicate that the forward array winch motor is leading the aft array winch motor, and readings to the right indicate the aft array winch motor is leading the forward array winch motor. The purpose of the selector switch is to make this orientation consistent for either the hoist or lower operation.

III-A-2-c Tension Indicator

Tension on each 2-3/4 inch diameter wire rope is observed on a dual meter. The indicator responds to the action of the torque arm on each of the bitter end sheaves against a strain gauge. Calibration on the meter scale is such that load on a single part of the 2-3/4 inch diameter wire rope is read directly. The strain gauges also are supplying signals to a recorder mounted to the right of the array winch console that charts the tensions throughout the operation.

NOTE: All tension indicator readings appearing in tables or on figures are based on the assumption that the weight of the array is evenly distributed between the fore and aft array winches.

III-A-3 Electric Cable Reel Controls (Fig. III-3)

Three controllers for operating each of the three electric cable reels are mounted on individual pedestals parallel to the ship's axis at the port side of the control station. The operator stands before the three controllers facing to port.

III-A-3-a No. 1 Controller (Single-Phase Cable)

This controller, to the left, operates reel no. 1, which is installed on the port side of the forward reel room. The cable from reel no. 1 passes through the port array well bulkhead seven feet forward of the array well aft

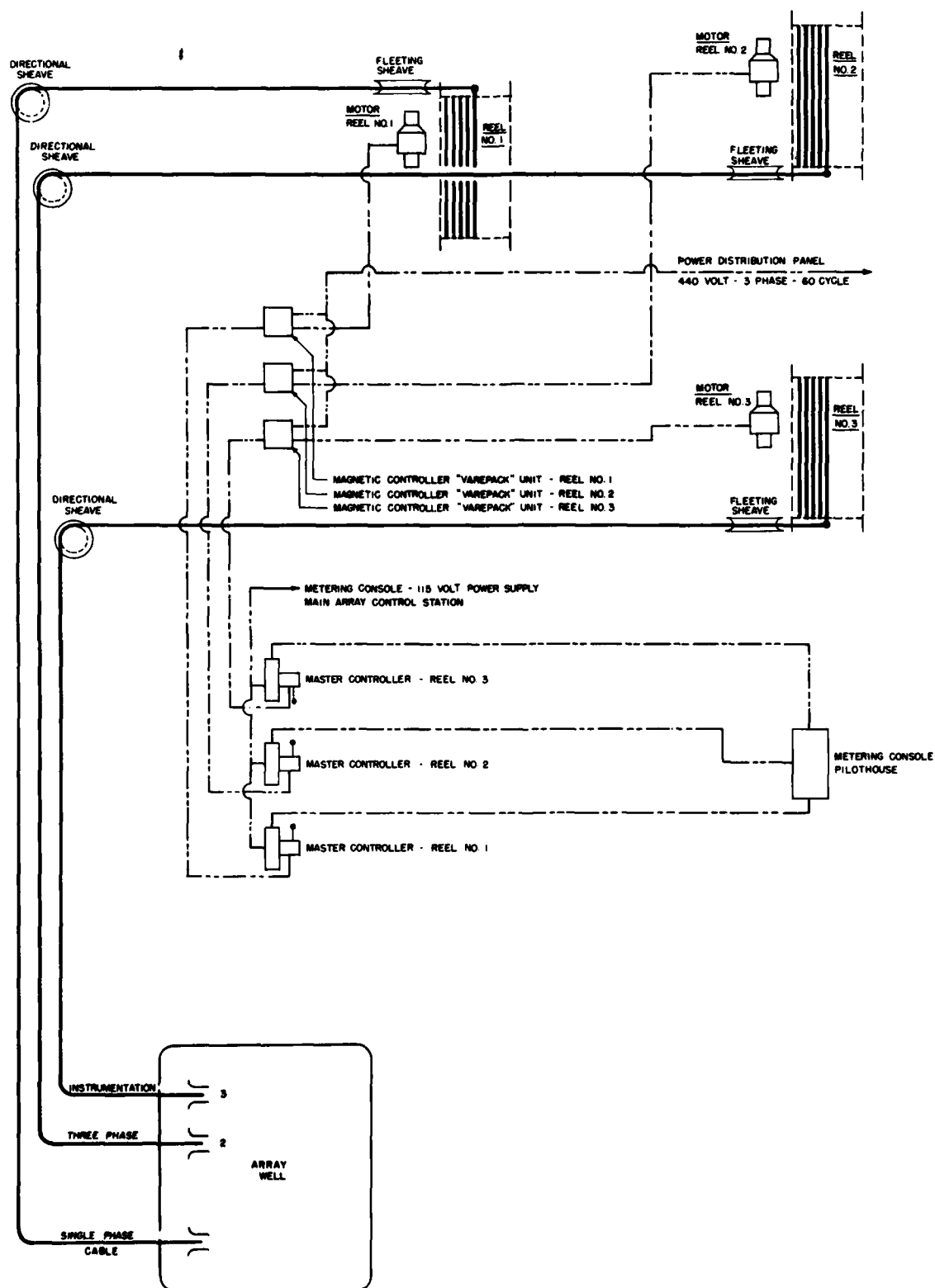


Fig. III-3 - Electric cable reel, composite arrangement

bulkhead and through a roller path guide to its bell and attachment on the array structure.

III-A-3-b No. 2 Controller (Three-Phase Cable)

This controller, in the center, operates reel no. 2, which is installed on the starboard side of the forward reel room. The cable from reel no. 2 makes a similar passage to reel no. 1 cable, and enters the array well fourteen feet aft of the array well forward bulkhead.

III-A-3-c No. 3 Controller (Instrumentation Cable)

This controller, to the right, operates reel no. 3, which is installed on the starboard side of the aft reel room. The cable from reel no. 3 also makes a similar passage and enters the array well seven feet aft of the array well forward bulkhead.

NOTE: The no. 1 and no. 2 controllers differ from the no. 3 controller in that the control levers of no. 1 and no. 2 are located on the right side of their respective pedestals and the no. 3 control lever is to the left of its pedestal.

No. 2 controller differs from no. 1 and no. 3 in that a control selector is mounted on the front face of the pedestal. The left position assigns all reel controllers to the array control station (main). The mid-position (aux. 1) and left position (aux. 2) assign the control of all reels to auxiliary stations, neither of which are operable at present.

THE SELECTOR SWITCH MUST BE IN THE MAIN POSITION THROUGH ALL PHASES OF THE ARRAY HANDLING OPERATION.

III-A-3-d Operation and Performance Selection

The operating levers are vertical in the off position. The controls for the reels afford the operator two types of performance of

each reel; one, constant speed pay-out or heaving-in, and, two, constant tension. A two-position selector switch is provided on each pedestal to select the performance required, "speed" or "tension". The operating lever, when in "speed" selection, pays out cable at speeds from zero to fifteen feet per minute on being pushed outboard from the vertical by the operator; pulling inboard from the vertical heaves in cable with a zero to 15 foot-per-minute speed range. The quadrant attached to each pedestal is calibrated to indicate the speed for both paying out and heaving in. With the selector switch on the "tension" position, the operation of the control lever is from vertical to inboard only, and the quadrant is calibrated from zero to 30,000 pounds tension. There are inherent characteristics of both tension and speed control which the operator must be aware of and exercise his judgment in the proper selection. These characteristics and their effects are described in section V. Raising and lowering of the array should be done using speed control only.

III-A-3-e "Power-On" Indicator Lights

These lights indicate that the circuitry has power and that the reels are ready for operation.

III-A-3-f "Emergency-Stop" Push Buttons

These buttons afford the operator a means of stopping the reel operation.

III-A-3-g "Emergency-Run" Push Buttons

These buttons are provided to the operator to bypass all overloads in the event that stopping the reels would jeopardize the operation. Corrective measures to reinstate overload protection should be undertaken at once.

III-A-4 Electric Cable Reel Consoles (Fig. III-4)

Each controller has its respective instrument console mounted on a stand behind the control pedestal. The electrical block diagram of a typical electric cable reel is schematically illustrated on figure III-5. The indicators and meters of a typical reel console with their functions are herewith listed.

III-A-4-a Length Indicator at Array Well

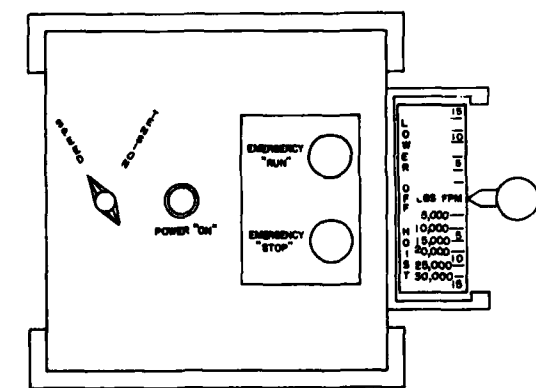
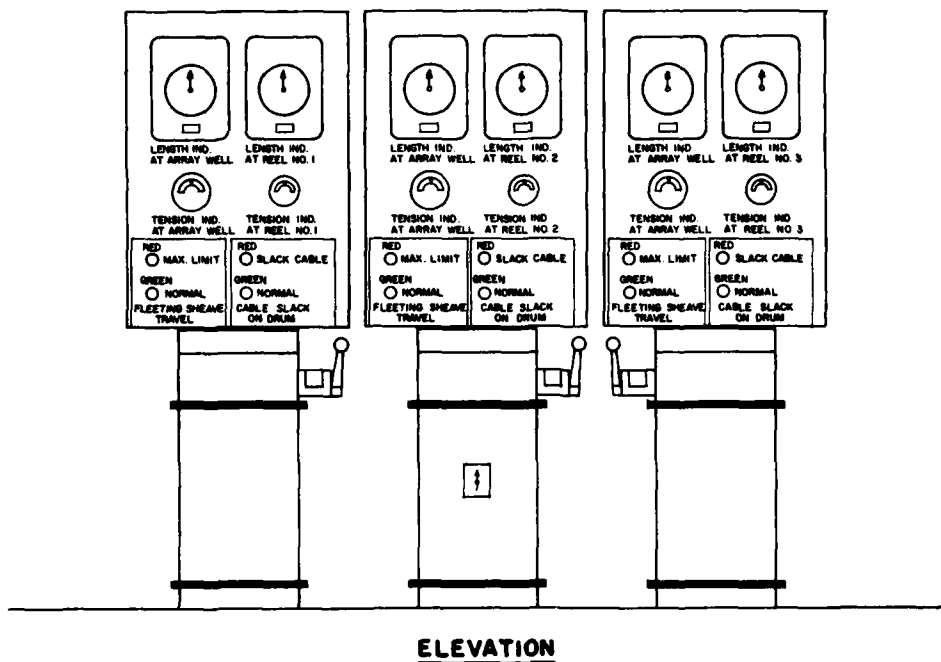
Readings indicate the amount of electric cable paid out from the stowed position of the array structure. (The "zero" reading on reels no. 1 and no. 3 must be offset because the cable entry into the array well is below the cable bells of the array. The cable of these reels will be reeved-in until the attachment of the array passes below the entry point. Therefore, the initial setting of reels no. 1 and no. 3 in the stowed position should be six feet. The initial setting of "length indicator" for reel no. 2 in stowed position is "zero".)

III-A-4-b Length Indicator at Reel

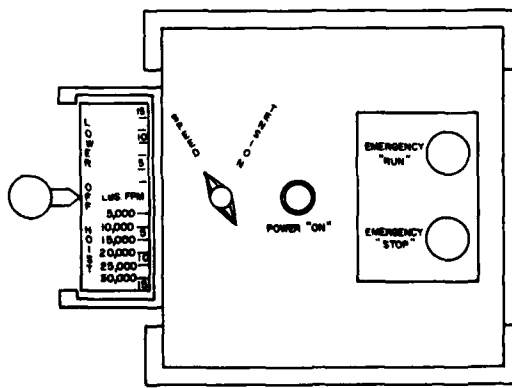
Reading serves as a check on the length indicators at array well. The differential between the length indicator readings signifies the presence and amount of slack cable between the array well and the reel. All initial readings are set as outlined in III-A-4-a.

NOTE: Reset all length indicators at III-A-4-a and III-A-4-b during the phase of operation, "cable guide installation position", to read the same as array winch "length indicator" reading (III-A-2-a). During lowering and raising, "speed" control shall be used, maintaining three (3) feet of slack at the reels.

The length of cable runs from the electric cable reels to the array well are herewith listed:



**ENLARGED TOP VIEW
OF MASTER CONTROLLER FOR
REEL NO. 1 (SIMILAR FOR REEL NO. 2)**



**ENLARGED TOP VIEW
OF MASTER CONTROLLER FOR
REEL NO. 3**

**Fig. III-4 - Electric cable reel, master controller
arrangement at array control station**

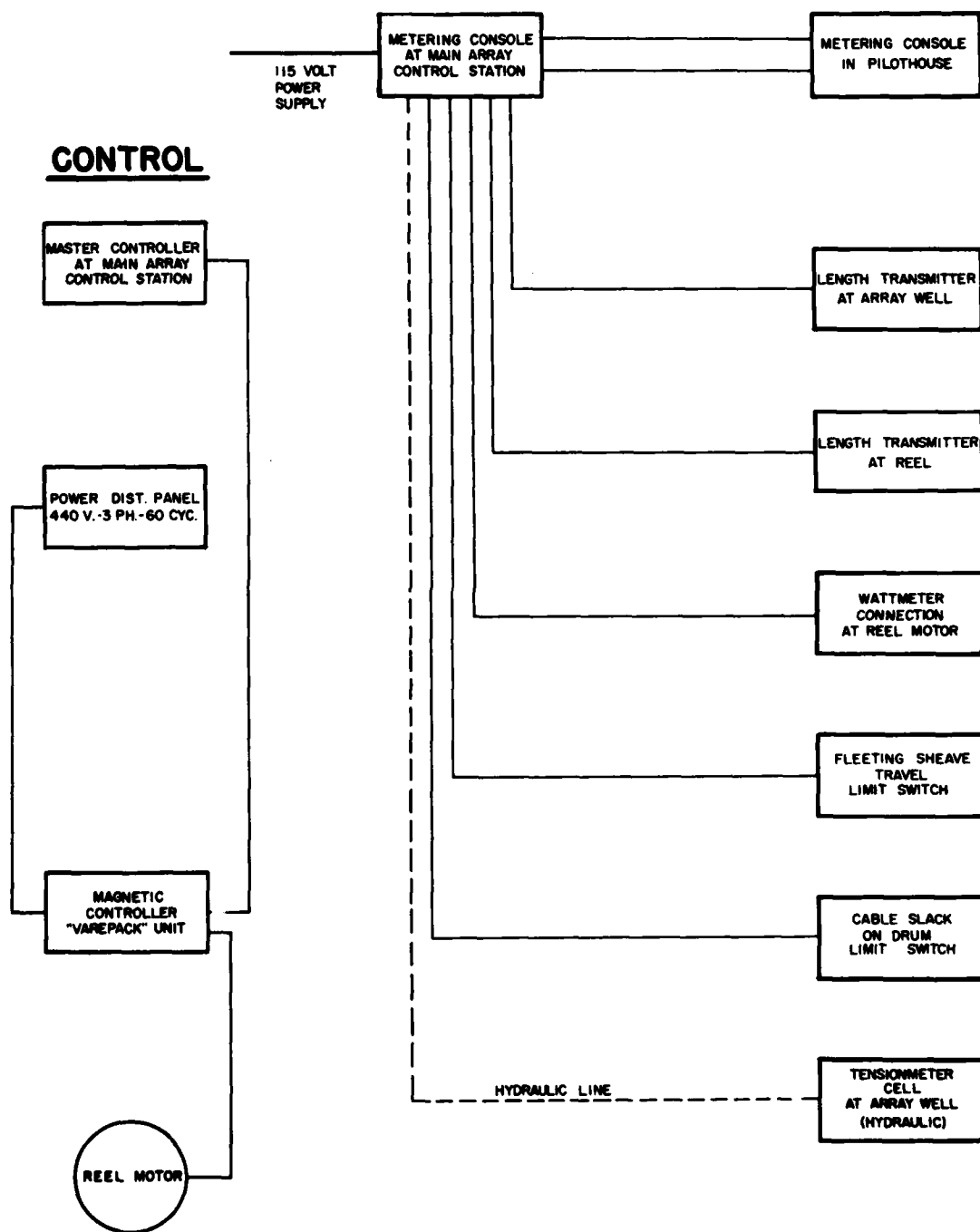


Fig. III-5 - Electrical block diagram, cable reel winches (typical)

Reel no. 1 - single-phase cable	252 feet
Reel no. 2 - three-phase cable	222 feet
Reel no. 3 - instrumentation cable	172 feet

III-A-4-c Tension Indicator at Well

Readings indicate the tension on the electric cable as it leaves the roller path guide at the array well. The indicator is hydraulic and is actuated by pressure applied by the free end of the roller path guide against a hydraulic load cell. The indicator is ineffective until the relief bell cable attachments on the array are below the roller path guides by an amount sufficient for the cable to have bearing over all supporting rollers of the roller path guide, a distance of approximately nine feet. The tensioning of the cable by the reel with performance on "tension" should be correlated with the tension indicator herein described. The tension setting on the controller will differ from the tension indicator reading by an amount equal to the friction loss of the cable guiding system from the array well to the reel. The designated tensions to be maintained at various depths, as set forth in Chapter II, refer to the tension indicator at well. The operator can set the control lever at a position that will produce the designated tension as indicated on the tension indicator at well. The tension corresponding to the calibration of the control lever quadrant may be used for reference.

CAUTION: SEE SECTION II-A-1 FOR CORRECTION FACTOR TO BE APPLIED TO CABLE TENSION INDICATOR READINGS.

III-A-4-d Tension Indicator at Reel

A polyphase wattmeter is installed in each reel console to indicate the power input to the respective reel motor. Since tension on the cable is a function of the power input, the face of the wattmeter has been recalibrated to read directly in "pounds tension".

III-A-4-e Fleeting Sheave Travel Indicator

Indicator lights, one red and one green, are provided to indicate that the remaining cable on the reel is not sufficient to pay-out for further lowering of the array. The green light is normally on during the entire operation. The red light appears when the reel fleeting sheave contacts a limit switch as the sheave nears its limit of travel. A switch for testing and replacement of indicator light bulbs is located at both red and green lights.

III-A-4-f Nitrogen Gas Supply

The array structure houses ten bottles of nitrogen gas at an initial pressure of about 2100 psi. This gas is used in the pressure release system of the transducer modules. There are two meters located on the second panel from the top of the instrumentation rack next to the no. 3 reel controller. These meters indicate the pressure in the nitrogen storage tanks and the difference in pressure between the ambient (water) and the pressure release system of the modules. There are two nitrogen systems, and, by changing the toggle switch from 1 to 2, the above pressures can be determined for each system. The instruction manual on the array structure provides detailed information relating to tank pressure, volume of gas and number of lowerings available. The instrumentation operator shall continuously monitor these and other instruments on this rack.

NOTE: This can be monitored in amplifier room also.

III-A-5 Current Indicator

There is located on top of structure one current meter, indicating current direction and velocity of water. Velocity and direction are relayed to the surface through cables to a recorder located alongside the amplifier console.

III-B ELECTRIC CABLE REELS - LOCAL CONTROL

The aft reel room contains electric cable reel no. 3 and the three Varepack magnetic control units, one for each of the three electric cable reels. (For details on Varepack magnetic control unit, see Electric Products Manual, reference 8.) A distribution board is located on the port bulkhead of the aft reel room for supplying power to the master controllers in the control station (III-A).

III-C STRAIN RELIEF BELL AND CABLE RELEASE ASSEMBLY

Each electric cable attachment to the array structure utilizes a strain relief bell and cable release assembly. The strain relief bell is a bell-shaped structure so designed to afford a long radius for the electric cable connection. The cable release assembly is provided to eliminate the possibility of weight of the array structure being taken by the electric cables. If the electric cables were to assume a tension in excess of 20,000 pounds, such tension shears the pin, allowing the armor clamp body to part from the assembly. Around the armor clamp body is a wire strap secured to the structure with slack in it; when pins shear, this wire strap takes up slack in cable, preventing further strain on electric cable between cable release assembly and components on structure. Re-installation of a parted cable, though time-consuming and tedious, is logically given priority over the possibility of parting the cable at some distance from the structure or upsetting the structure. Coordination between array winch operation and electric cable reel operation is essential in maintaining electric cable tensions within designated limits.

III-D ARRAY STRUCTURE-GUIDE-ORIENTATION MARKING AT ARRAY WELL (Fig. III-6)

The fixed guides and buffer guides have draft marks in three-inch increments painted around the guide structure for orienting the position of the array with respect to the hull. The markings serve the further purpose of allowing the fore and aft or cross level of the array to be readily ascertained by the observer stationed either on the main deck or on the catwalk adjacent and parallel to the port array well bulkhead.

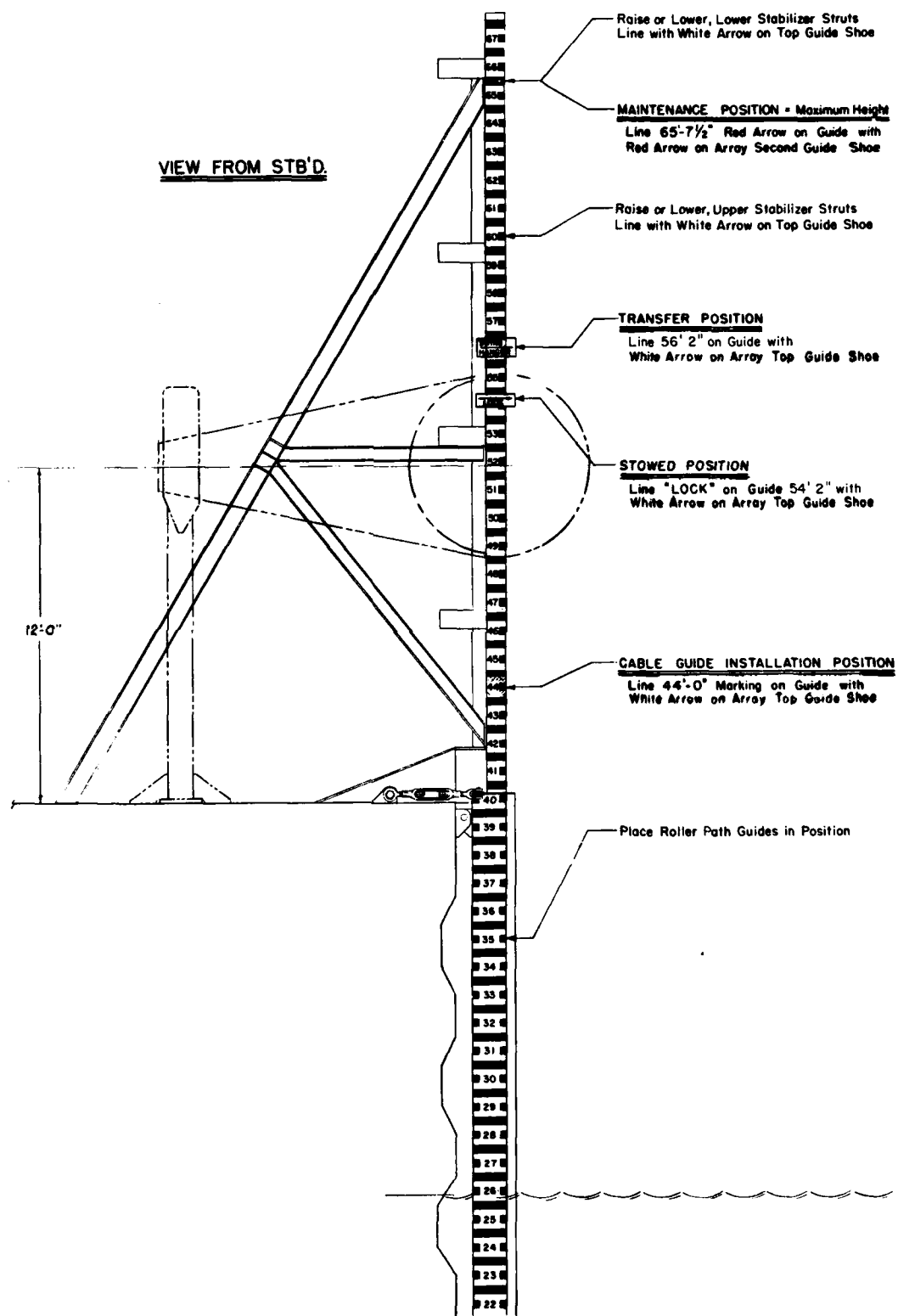


Fig. III-6 - Array structure-guide orientation markings at array well

The array guide shoes have arrows that, when lined up with reference markings on the guides, establish the positions of the array where the operations of lowering or raising are stopped for application (or removal) of guide devices, stowing devices, or maintenance, as noted on figure III-6.

NOTE: The positions as indicated on figure III-6 are further correlated for each position of operation as it appears in Chapter V.

III-E ARRAY GUIDE DEVICES AT WELL

III-E-a Fixed Guides (Fig. III-7)

Two sets of guides, one at the forward array well bulkhead, and the other at the aft array well bulkhead, extend above the main deck 28 feet. The guides, by restraining longitudinal and transverse movement of the guide shoes affixed to the array structure, stabilize the array structure while it is in the confines of the array well during maintenance, stowing, initial phase of lowering, and final phases of raising.

III-E-b Shock Mounted Guides (Fig. III-7)

Two guide assemblies, each singly hinged from the main deck and in line with the fixed guides of III-E-a, extend below the main deck to within six inches of the ship's bottom. The bottom of the guide structure is flared to afford nine feet, six inches, opening, and tapers to one foot, six inches, opening at the 16 feet waterline for restraint to the guide shoes on the array structure. These assemblies are, in turn, restrained to six inch movement in each direction from port and starboard by buffers mounted at the ten feet, six inches, waterline. The function of the buffers is to dampen the impacts caused by transverse action of the array structure from the roll of the ship during the final phase of exit, or the initial phase of re-entry into the confines of the guides. The flared portion of the guide is designed to accommodate a roll of eight (8) degrees and a pitch of one and one-half (1-1/2) degrees.

III-E-c Roller Path Guides and Tracks (Fig. III-7)

Two sets of tracks, one attached to the forward array well bulkhead and the other to the aft array well bulkhead, extend from three feet above the main deck to 15 feet waterline. Each set of tracks provides a guide and locking device for its respective rope roller path guides. The rope roller path guide serves as a load transfer point to the two-part supporting 2-3/4 inch wire rope at each end of the array. Each part of the 2-3/4 inch wire rope is in line with its respective line sheave and bitter end sheave, as well as being in line with the grooves of the yoke-mounted travelling sheave on the array. The roller path guides in the locked position are so located to afford minimum translation of movement to the array structure from the roll of the ship. See figure V-7 for rope roller path guide engaging in track.

AFT ARRAY WELL BULKHEAD SHOWN

FWD. ARRAY WELL BULKHEAD SIMILAR AND OPPOSITE

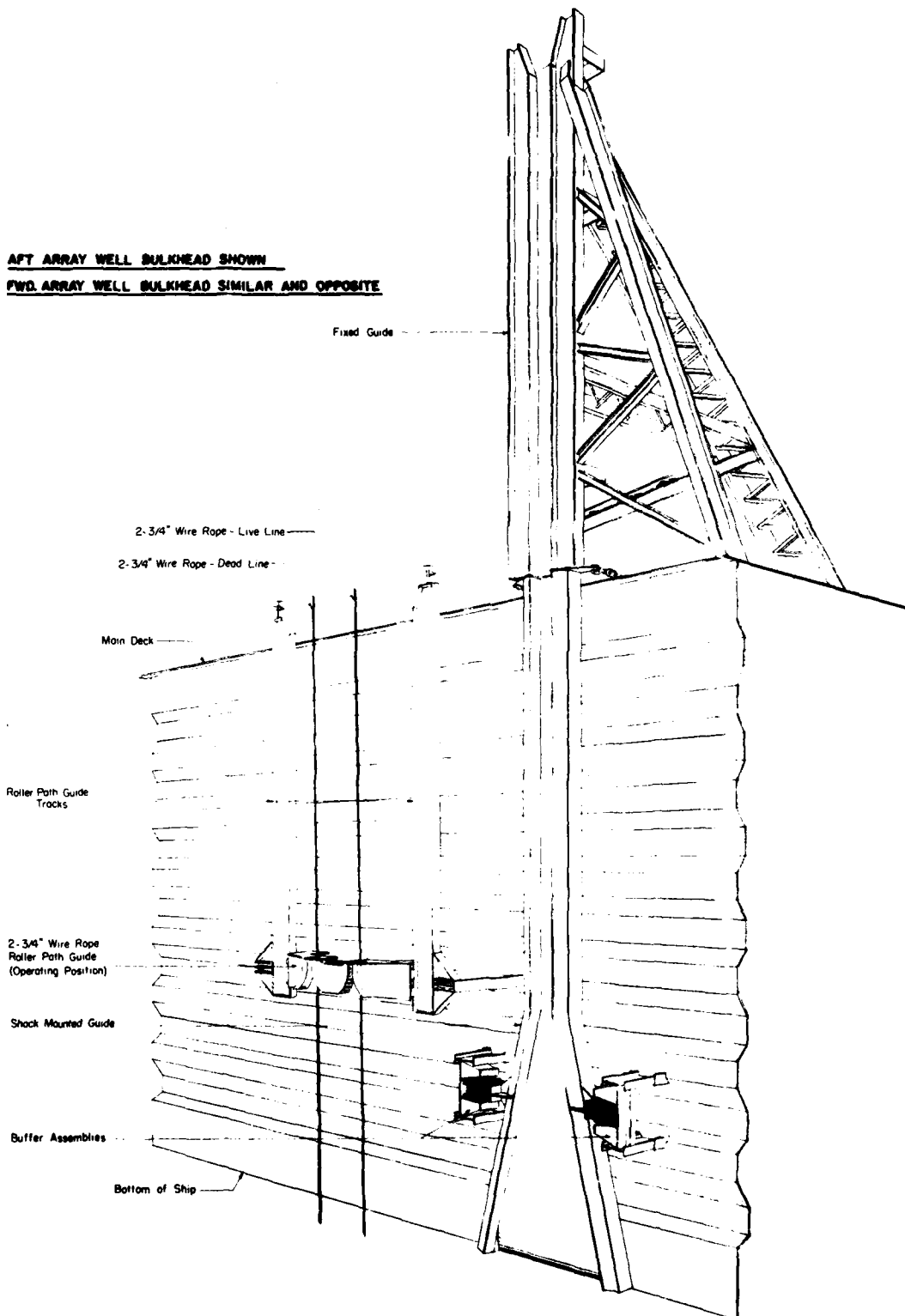


Fig. III-7 - Array guide devices at well

CHAPTER IV
PERSONNEL ASSIGNMENT, DUTIES AND INSPECTIONS

IV-A PERSONNEL ASSIGNMENT AND DUTIES

IV-A-1 It will be the duty of all on-duty personnel to maintain, on a continuing basis, a vigilant watch on the equipment within their area of operation during the lowering and hoisting of the array. Any condition of malfunction or damage to the components that could jeopardize the operation shall be immediately reported to the array control station supervisor. All malfunctions or damage sustained to any of the components are to be placed "on report". It will be to the discretion of the control station supervisor to determine whether or not continuance of the operation is to be undertaken without correction of the reported malfunction or damage.

The stations with personnel requirements and equipment items within the area of the station are as follows:

IV-A-1-a Array Control Station (Telephone Communication)

Personnel

Array control station supervisor
Array winch operator
Electric cable reel #1 operator
Electric cable reel #2 operator
Electric cable reel #3 operator
Array instrumentation operator
Bow thruster operator when required

Equipment

Array winch controllers
Electric cable reel controllers
Array winch console

Electric cable reel consoles
Array instrumentation console
Sound powered telephones
Bow thruster controller

NOTE: In that the array control station supervisor is available at this station, he will be kept informed of the functioning of the metering devices, indicators and instrumentation by the operators at the array control station.

1-A-1-b Array Well

Personnel 1 officer in charge
 4 seamen (ship's crew)

Duties

Care and operation of equipment used in opening and closing array well door - tagline winch and rope gear.

Care and operation of stabilizing struts and support hangers.

Condition of electric cable roller path guides. Alignment with respect to bells on array.

Condition of fixed guides and visible portion of buffer guides.

Inspect electric cable connections on array. Note evidence of movement of electric cable armor with respect to the armor clamp body of the cable release assembly.

Care, installation and stowing of rope guide sleeves. Inspection of attachment.

Inspection of electric cables during lowering and hoisting operation. Also, stand by to notify array control station of possible fouling of electric cable on appurtenances.

Condition of array with respect to being free of unattached tools, objects, scaffold boards, or hanging lines that could cause fouling.

Assist array control station supervisor by hand signaling fore and aft level attitude of the array when in the confines of the array well.

Observe "live" sheaves for proper functioning during lowering and hoisting operation. Check grooves for excessive wear evidenced by wire impressions and chafing action.

Check chains and sprockets of footage counter at intervals during lowering and hoisting operation for being intact.

Check load cell mounting bolts for working loose during lowering and raising operation.

Supervise lubrication of fore and aft 2-3/4 inch diameter wire ropes during hoisting operation.

Inspect fore and aft yoke-mounted sheaves on array during array maintenance operation. Check grooves for wear, and yoke attachment to array.

NOTE: (1) On hourly intervals during the operation of lowering and hoisting (after the stabilizing devices have been stowed and the rope guide sleeves and roller path guides installed), a team of two men should be dispatched to inspect the equipment installed in the electric cable trunk under the port deck extending from the array well to the forward reel room. The equipment is as follows:

Check horizontal cable guide quadrants (one for each of three electric cables) at port array well bulkhead. Note action of rollers

for being free to turn. Take corrective measures to free up frozen rollers. Check footage counters for being intact.

Observe each of eighteen vertical guide sheaves for being free to turn. Take measures to free up frozen sheaves.

Observe rotation of three horizontal sheaves for being free. Check sheave grooves for excessive wear. Check mounting and pin keeper devices for being intact.

(2) During operation, an officer from the Engineering Department shall make continuous inspections of all mechanical and electrical machinery, making note of any unusual noises, excessive temperatures or any unsatisfactory condition. Unsatisfactory conditions shall be reported to the ONR Project Representative at once.

IV-A-1-c Forward Array Winch

Personnel Seaman

Duties

Condition and operation of pawls and ratchets. Check for having proper alignment. Check workability of keeper pins.

CAUTION: INSURE THAT PAWL KEEPER PIN IS "OUT" WHEN HOISTING.

Condition of bull drive. Inspect at intervals during operation of lowering and hoisting for adequacy of lubrication, full tooth bearing alignment with driving pinion and abnormal wear.

Condition of drum bearing. Check for evidence of loosening in bearing cap bolts, overheating and smoothness of operation.

Condition of hydraulic motor drive. Observe for end-play in jack shaft and couplings, looseness in bearing hold-down bolts, and overheating of bearings.

Condition of electric motor pump drive. Observe for looseness in motor and pump hold-down bolts, and for overheating of motor bearings.

Condition of hydraulic piping. Check system for leakage at all high pressure connections. Report evidence of leakage to array control station supervisor immediately to prevent "cutting-out" of gaskets.

Condition of tachometer drive. Observe drive for being intact and adequately lubricated, at intervals during lowering and hoisting operation.

Observe spooling during hoisting operation for being free of piling or improper fleeting onto drum. Notify array control station supervisor of improper spooling.

Observe hydraulic pump and motor operation for smoothness. If jerkiness develops, notify array control station supervisor.

Check for motion indicating looseness of any winch foundation bolts.

Inspect wire rope during hoisting operation for evidence of broken wires, crushing, high strands, and kinks. If any of the above conditions exist, note condition, position on drum with respect to flanges, and time that particular section of wire rope engaged drum wrap. Notify array control station supervisor.

IV-A-1-d Aft Array Winch

<u>Personnel</u>	Seaman
<u>Duties</u>	Listing identical to IV-A-1-c

IV-A-1-e Three Electric Cable Reels

<u>Personnel</u>	Engineer - Reel #1 (Single Phase)
	Engineer - Reel #2 (Three Phase)
	Engineer - Reel #3 (Instrumentation)

Duties

Condition and operation of pawls and reel ratchets. Check for having proper alignment.

Inspect foundation bolts, bearing hold-down bolts, main reel gear flange bolts, motor base hold-down bolts, and gear reducer hold-down bolts for evidence of working loose while in operation.

Inspect auxiliary drums while in operation. Note condition of universal joints for being intact with retainer devices in place. (This inspection to be made from exterior of main reels).

Note condition and action of Tirex cable on auxiliary drums inside main reel while in operation. Check for damage by chafing within the reel and in the cable passage through the shaft. (This inspection to be made from exterior of main reels.)

Check main gear and pinion alignment for full tooth bearing, excessive wear and adequacy of lubrication.

Observe mesh of gears on auxiliary drums for maintaining proper alignment while in operation.

Prior to operation, actuate fleeting sheave limit switch by hand. Indicator lights on reel consoles in array control station should change from "green" to "red".

Examine electric cable when heaving in during hoisting operation for evidence of damage to armor. Indicate damaged sections by chalk marks for further inspection on completion of operation. Notify array control station supervisor.

Examine Morse torque limiter clutch coupling. Must be free of oil or grease. Rectify any condition that would allow oil or grease to reach coupling by dripping or otherwise.

Note alignment of fleeting sheaves with respect to reel. Cable should not be crowded by previous wrap.

Inspect lead screw drive components for being intact while in operation.

Examine lead screw while in operation for adequacy of lubrication, and evidence of undue seizure of traveling nut. (Thread faces would be scored.)

Observe fleeting sheave bearing mounting bolts during operation for evidence of having worked loose.

Inspect fleeting sheave during operation for evidence of excessive wear.

Notify array control station of any evidence of malfunction of any equipment.

IV-A-1-f Electric Cable Reel Control Station (Aft Reel Room)

<u>Personnel</u>	Supervisor
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<u>Duties</u>	
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Supervise personnel of section IV-A-1-e.

Attend three drip-proof enclosures, one for each reel, containing magnetic control circuitry for controlling the electric cable reels throughout the lowering and hoisting operation.

Vacuum control cabinets free of accumulated dust prior to lowering and hoisting operation.

Observe reel motors at intervals during operation for evidence of brush sparking. Put on report for dressing, replacement or other corrective measures. Notify array control station supervisor if sparking is of such magnitude that breakdown could occur before completion of the operation.

Operate master switch on port bulkhead on orders from array control station supervisor only. Retain possession of key to lock on door of master switch cabinet.

Always advise array control station supervisor of intention to interrupt service.

IV-B INSPECTION PRIOR TO OPERATION

Personnel assigned to each station as outlined in IV-A, will conduct the inspection of the equipment within the area of their station while the vessel is en route to the operation site. The scope of the inspection will include a check on measures taken in correcting malfunctions or damage sustained from the previous operation, that were on report, a check in all areas for being free of debris, tools or unsecured objects, and a check on the proper functioning of control devices.

Lubrication of all components will take place simultaneously with this inspection. (It is anticipated that the components will have been lubricated subsequent to the previous operation; however, lubrication at this time will purge the systems of condensates and dust accumulations.

IV-B-1 Fore and Aft Array Winch Systems

IV-B-1-a Array Winch Motors

Check operation of "Power-On" indicator light in control station. Check electric motor "start" and "stop" buttons in control station.

IV-B-1-b Hydraulic System

Check reservoir level. Check system for being free of air by noting response of hydraulic motor to controllers in control station (tensions on array winch wire rope can be raised and lowered in small increments).

IV-B-1-c General. Inspect winches for having all guards in place. Clear area for accessibility to operation of pawls. Clear area and clean deck of all fouling objects, debris, and grease deposits from over-lubrication. Check items that were on report from previous operation for having been corrected. Stow fixtures, tools, or equipment used in accomplishing repair. Remove scaffold board brackets that are hazardous to personnel.

IV-B-2 Electric Cable Reel Systems

IV-B-2-a Master controllers

Line up circuitry to supply power to the reel master controllers. Pull pawls from locked position at reels. Inch reel drum forward and in reverse to insure proper response.

IV-B-2-b Cable Passage

Check through entire cable runs for removal of all debris, unsecured objects, and tools that could cause fouling.

IV-B-2-c Array Connections

Check strain relief bells and roller path guides for being free of obtrusions that could cause fouling. Remove all scaffold brackets and superficial materials.

IV-B-3 General

IV-B-3-a Array Structure

Check structure for being free of unused bolts and nuts, scaffold boards, or any materials that are not a part of the assembly.

IV-B-3-b Array Well Deck Area

Clean deck around the array well. Remove all materials that are superficial to the operation from the area.

CAUTION:

ALL ITEMS LISTED IN THIS SECTION (IV-B)
THAT ARE FOUND TO BE IN A CONDITION
THAT COULD CONTRIBUTE TO FAULTY
OPERATION SHALL BE CORRECTED BEFORE
STARTING THE LOWERING AND HOISTING
OPERATION.

CHAPTER V

DETAILS OF THE LOWERING AND HOISTING OPERATION

Operating procedures are set forth in sections, one section for each phase of the lowering and hoisting operation.

The chronological sequence developed in this chapter starts with the array in the stowed position (Fig. V-1). Each section thereafter progresses in the hypothetical operation of transferring from stowing devices to array handling equipment, the manipulation within the confines of the array well for installation of guide devices, the lowering of the array to operating depth, the holding of the array at operating depth, the hoisting for re-entry into the array well, the manipulation within the array well for detachment of guide devices, and the installation of stowing devices for transport.

In addition, a second hypothetical operation is set forth similarly in which the sequence again starts with the array in the stowed position, progresses through detachment of stowing devices, hoisting to an accessible position for maintenance, lowering to stowed position, and attachment of stowing devices for transport.

Sketches and operating data tables are included where deemed necessary.

CAUTION: THE PROCEDURE DESCRIBED HEREIN FOR THE OPERATION OF THE ELECTRIC CABLE REELS COVERS SPEED. THE FOLLOWING PRECAUTIONS ARE NOTED FOR EACH FORM OF CONTROL:

SPEED. Taking in slack cable by speed control will develop the full pull of 30,000 pounds of the reel with 150 percent overload immediately after the slack is removed. Also, speed control will build up large inertial forces once the slack in the cable is removed. Speed control is operable both in paying out and hoisting in.

TENSION. Tension control shall not be used for operations described in this book.

The use of the figures in Chapter II is recommended as a guide to the proper operation of the system.

TENSION INDICATOR READINGS			
	STOWED		HOIST
2 MODULES	30000" MIN	50000" MAX	71,000"
10 MODULES	30000" MIN	50000" MAX	112,400"
20 MODULES	30000" MIN	50000" MAX	150,000"

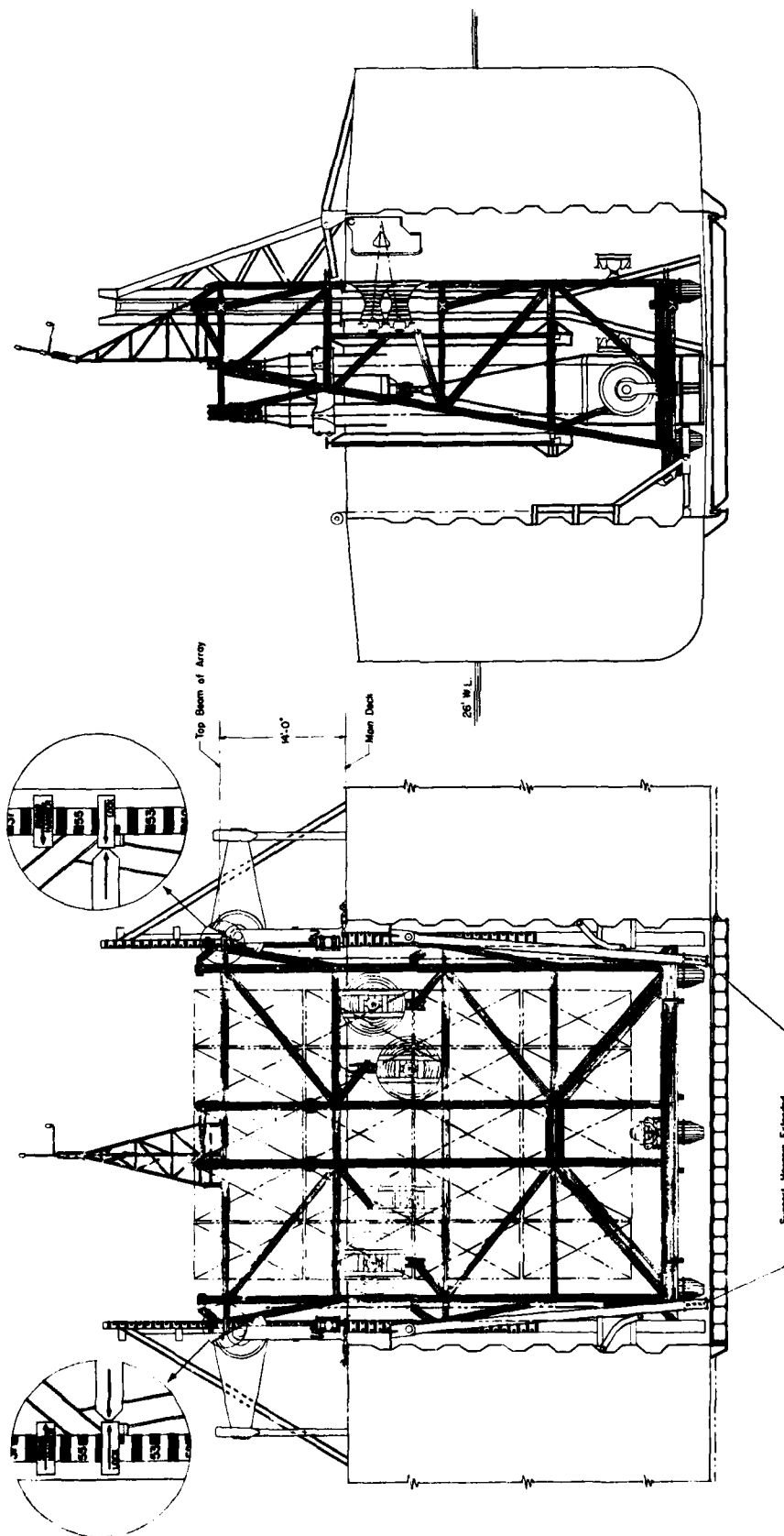


Fig. V-1 - Array in stowed position

V-A TO TRANSFER ARRAY STRUCTURE FROM STOWING DEVICES
TO ARRAY STRUCTURE HANDLING EQUIPMENT

V-A-1 To Open Bottom Door (Fig. V-2)

- V-A-1-a Start tagline winch. Secure drums and drum clutches. Use forward gypsy for pulling door open. Use aft gypsy for snubbing.
- V-A-1-b Check all operation cable for being free from possibility of fouling.
- V-A-1-c Withdraw locking pins. Handwheels (2), located port and starboard at forward corners of array well. Apply tension on snub line to keep door against aft stops. Use full travel of withdrawal screw, approximately 88 turns for 22 inch travel. (If locking pins do not pull using handwheel leverage only, additional power to the screw for a maximum torque of 400 foot pounds is permissible. Reciprocating action produced by alternate pulls on the line on the fore and aft gypsy spools will aid in releasing locking pins.)
- V-A-1-d Pull door open using forward gypsy. Pay off snub line on aft gypsy.

The position of the yokes in the tracks running fore and aft can be used to ascertain the approximate position of the door.

NOTE: If door does not pull free of the stowed position, it is highly probable that the roller tracks have accumulated deposits of sand or fouling materials. Dispatch diver with fire hoses to wash away fouling materials.

- V-A-1-e With door against forward stops, release tension on aft gypsy snub line and maintain tension on forward gypsy line to hold door against forward stops.

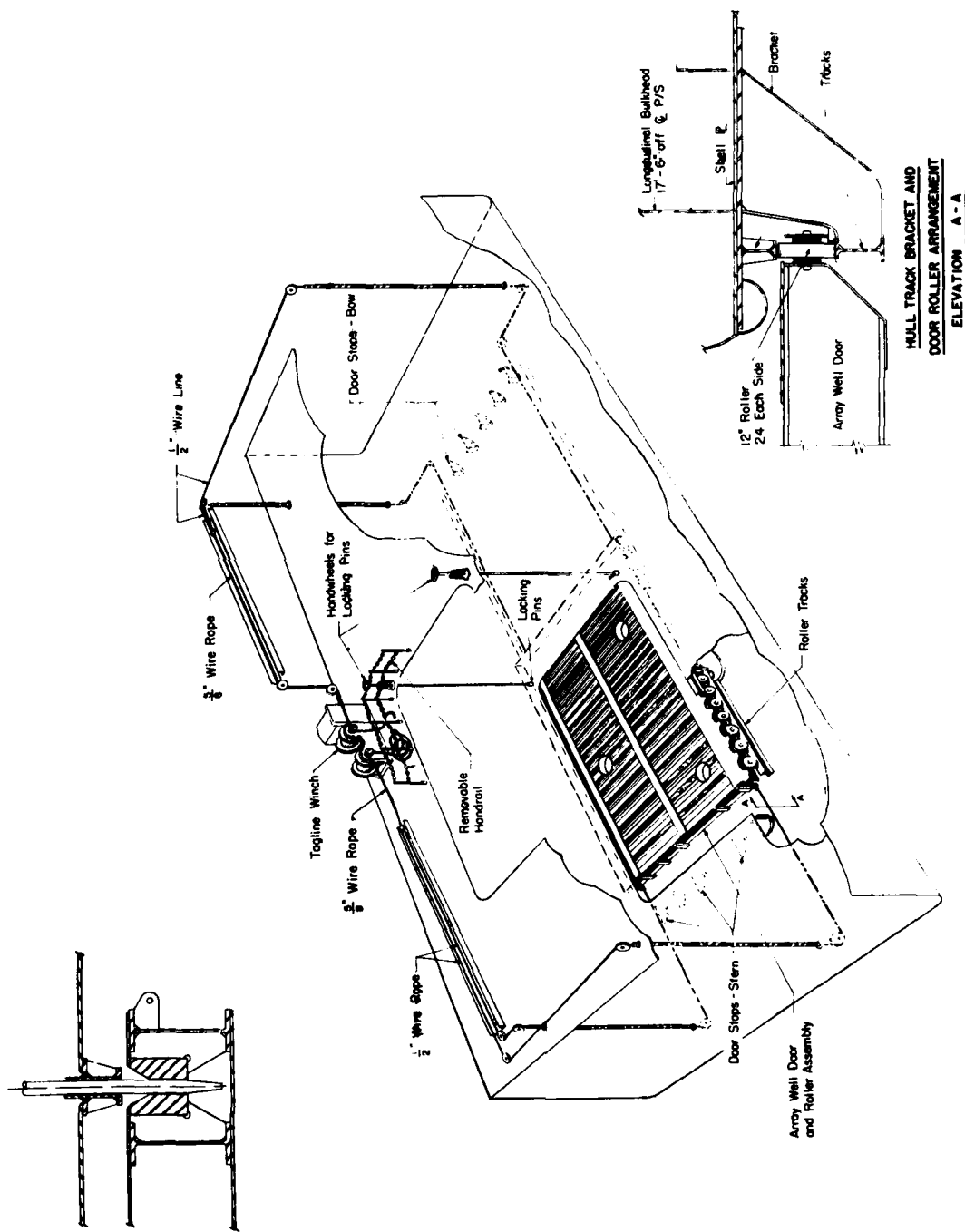


Fig. V-2 - Schematic, array well door opening and closing arrangement

V-A-1-f Extend locking pins to full travel. Release tension on forward gypsy. Alternate pulls on the lines may be necessary to allow pins to reach full travel - 88 turns for 22 inch travel.

V-A-1-g Stow operating cable.

V-A-2 Stow portable handrail stanchions from port midpoint of array well opening forward and transverse toward ship centerline to vertical guides.

V-A-2-a Remove canvas cover from top of drift indicator and stow in locker. Remove chain, toggles and stanchions and stow.

V-A-3 Check two length indicators on array winch consoles for zero reading with tension indicating load in excess of 30,000 pounds but not exceeding 50,000 pounds.

V-B TO RAISE ARRAY STRUCTURE FROM STOWED POSITION

V-B-1 Check control levers for being in "off" position on array winch controllers and electric reel controllers.

V-B-2 Check for power to array winch hydraulic pump motors and electric cable reel controllers. (Indicator lights - "power on".)

V-B-3 Put three reel selector switches to "speed" control and pay out cable. Have cable room personnel inform reel operator the amount of slack in cable. Reel operator to keep two feet of slack at reel.

(Reel no. 2 electric cable roller path guide is feeding cable downward approximately two feet to its relief bell on the array. Reels no. 1 and no. 3 roller path guides are feeding cable upward approximately two feet to their respective relief bells on the array.)

V-B-4 Take up array winch tension individually to equalize reading on fore and aft tension indicator to within 6000 pounds prior to assuming total weight of array structure from support hangers.

V-B-5 Using slow array winch speed, raise the array structure approximately two feet. Stop winches. Top beam of array to be 16 feet, two inches above main deck. (Fig. V-3) Footage counter reading of 99997.8.

V-B-6 Pull pawls to full disengaged position on both fore and aft array winches and insert lock-out pin.

V-B-7 Hold in this position. All controls on "stop".

(Tension indicator readings on array winch console, with array in partially immersed condition, should read approximately as listed below, depending on number of modules.)

2 modules	71,000 pounds
10 modules	112,000 pounds
20 modules	150,000 pounds

(See Table V-1 for weight of array in complete immersed condition and dry condition.)

V-B-8 To Retract Support Hangers (Fig. V-4)

V-B-8-a Two 2-ton Beebe hoists are mounted with drum centers four feet, zero inches above the main deck, one 1-foot, zero inches forward of the forward array well bulkhead, and the other one foot, zero inches aft of the aft array well bulkhead. Both winches are mounted with drum shafts transverse to the hull with lines guided by sheaves into the array well near the port well bulkhead.

V-B-8-b Drum rotation to retract is accomplished by unspooling. Movement of the hangers is visible from the main deck. The hangers are pulled hard against respective fore and aft bulkheads with a wire rope connected to the center of hanger. This wire rope is led through three sheaves to main deck where it is secured to pad eye on deck with turnbuckle.

V-B-8-c Set pawl in winch ratchet to secure.

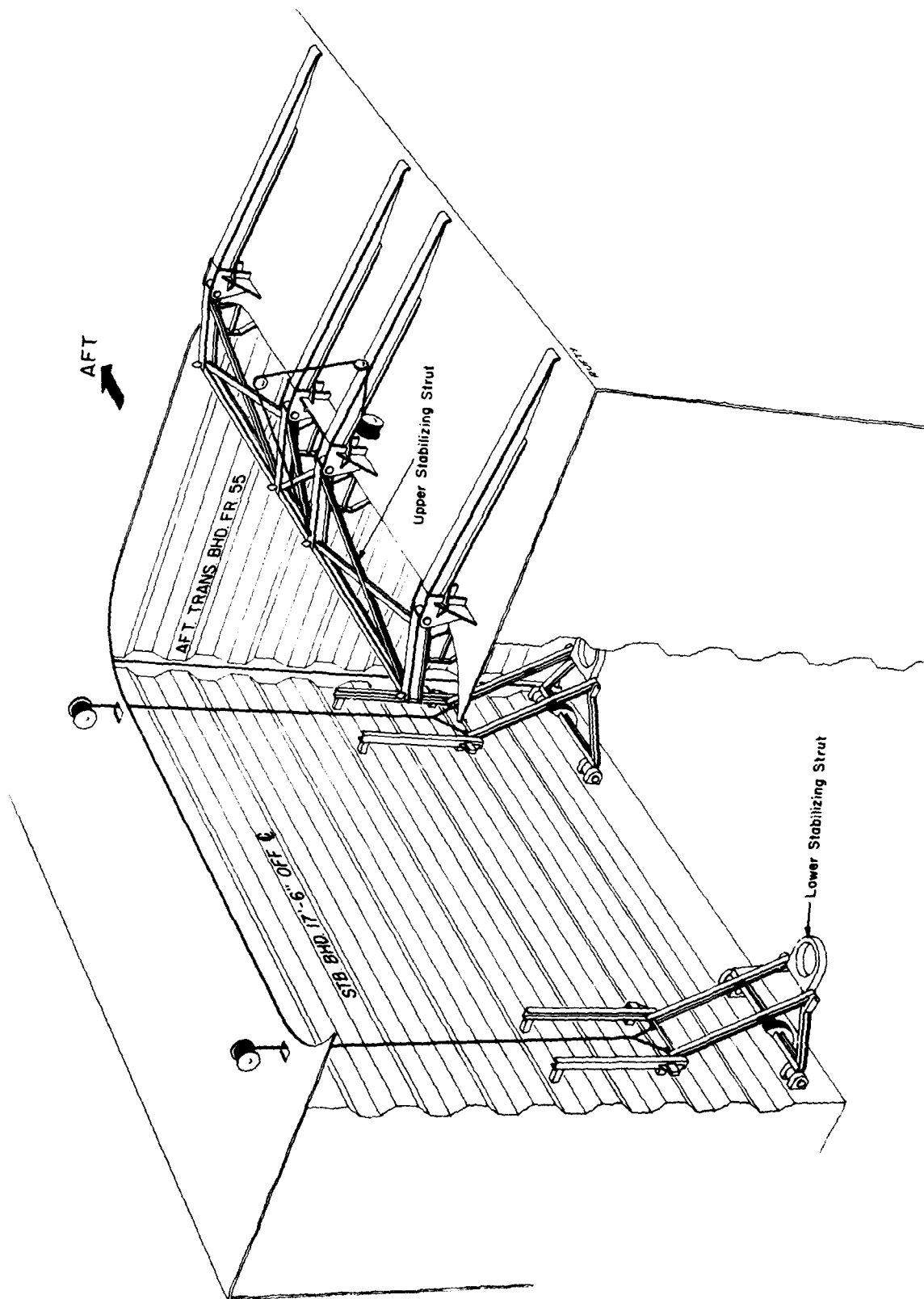


Fig. V-3 - Stabilizing struts

Table V-1 - Weights - Array Structure and Components

NAME	2 MODULES		10 MODULES		20 MODULES	
	Pounds DRY	Pounds IMMERSED	Pounds DRY	Pounds IMMERSED	Pounds DRY	Pounds IMMERSED
Array Structure - Nz Bottles - Bells	208,000	182,000	208,000	182,000	208,000	182,000
Instrumentation Capsule	2,500	2,000	2,500	2,000	2,500	2,000
Transducer Modules	31,000	22,200	155,000	111,000	310,000	222,000
Electric Cable and Miscellaneous	1,000	500	1,000	500	1,000	500
Ballast	58,000	52,800	42,000	38,200		
Massa Junction Box	1,200	600				
G E Junction Box			23,000	7,000	23,000	7,000
Component Tanks			70,000	28,000	140,000	56,000
Instrumentation Junction Box			1,800	750	1,800	750
Total	301,700	260,100	503,300	369,450	686,300	470,250
Load Per Line						
Tension Indicator Reading	75,425	65,025	125,825	92,363	171,575	117,563

TENSION INDICATOR READINGS	
2 MODULES	71,300 POUNDS
10 MODULES	112,700 POUNDS
20 MODULES	150,300 POUNDS

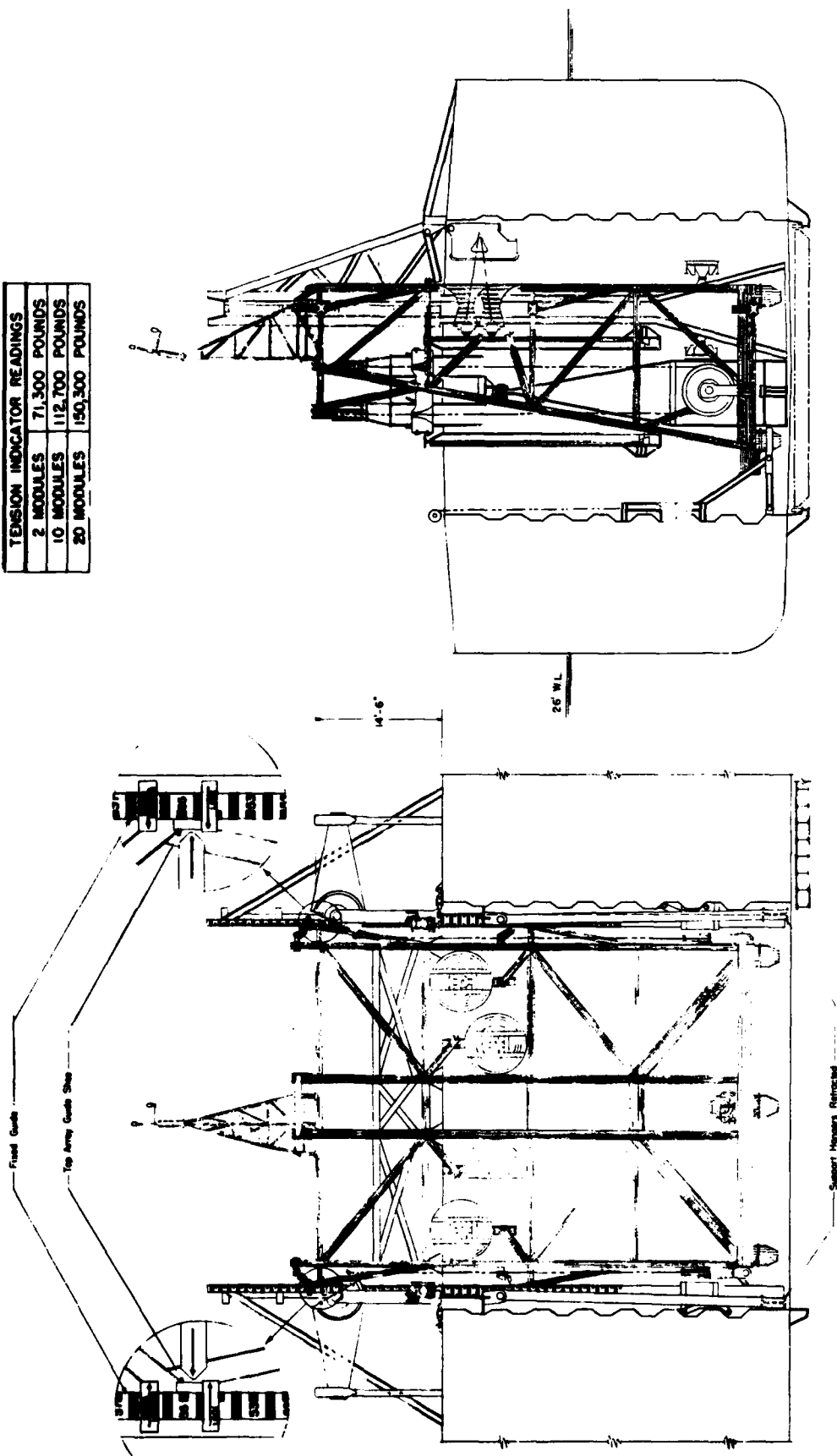


Fig. V-4 - Array 6 inches above stowed position for retraction of support hangers

V-B-9 To Unlock and Store Upper Stabilizer Struts on Port Side (Fig. V-5)

- V-B-9-a** From swing hanger position, raise structure to 60 feet using upper guide shoe on array structure as reference point (footage counter 99994.0). This removes stabilizers from struts.
- V-B-9-b** Remove four toggle pins from stabilizer struts.
- V-B-9-c** Feed wire rope through fairlead sheaves to align with forward gypsy head on tagline winch. Make three turns on gypsy head.
- V-B-9-d** Start tagline winch and raise stabilizer strut to stowed position alongside catwalk. Secure strut to catwalk with turnbuckles at catwalk.

V-B-10 To Unlock and Stow Lower Stabilizer Struts (Fig. V-5)

- V-B-10-a** Raise array structure to 65-1/2 feet using upper guide shoe for reference point (footage counter reading 99987.5).
- V-B-10-b** Two hand-operated winches are located on the starboard side, main deck at well edge. One is six feet from forward transverse bulkhead at frame 59 and the other six feet forward of after transverse bulkhead frame 55. In addition to the winch, a handwheel is provided for engaging and disengaging a locking bar which holds the stabilizers in place when in the raised to stowed position.
- V-B-10-c** To unlock and raise forward and after stabilizer strut, turn forward handwheel counterclockwise and the after handwheel clockwise one-half turn or until locking bar hits stops.
- V-B-10-d** Remove winch cranks and engage in end of crank shaft. Lower pawl in place on gear. Commence turning cranks in hoist direction until lower part of yellow marking on cable becomes even with opening in deck for wire rope.

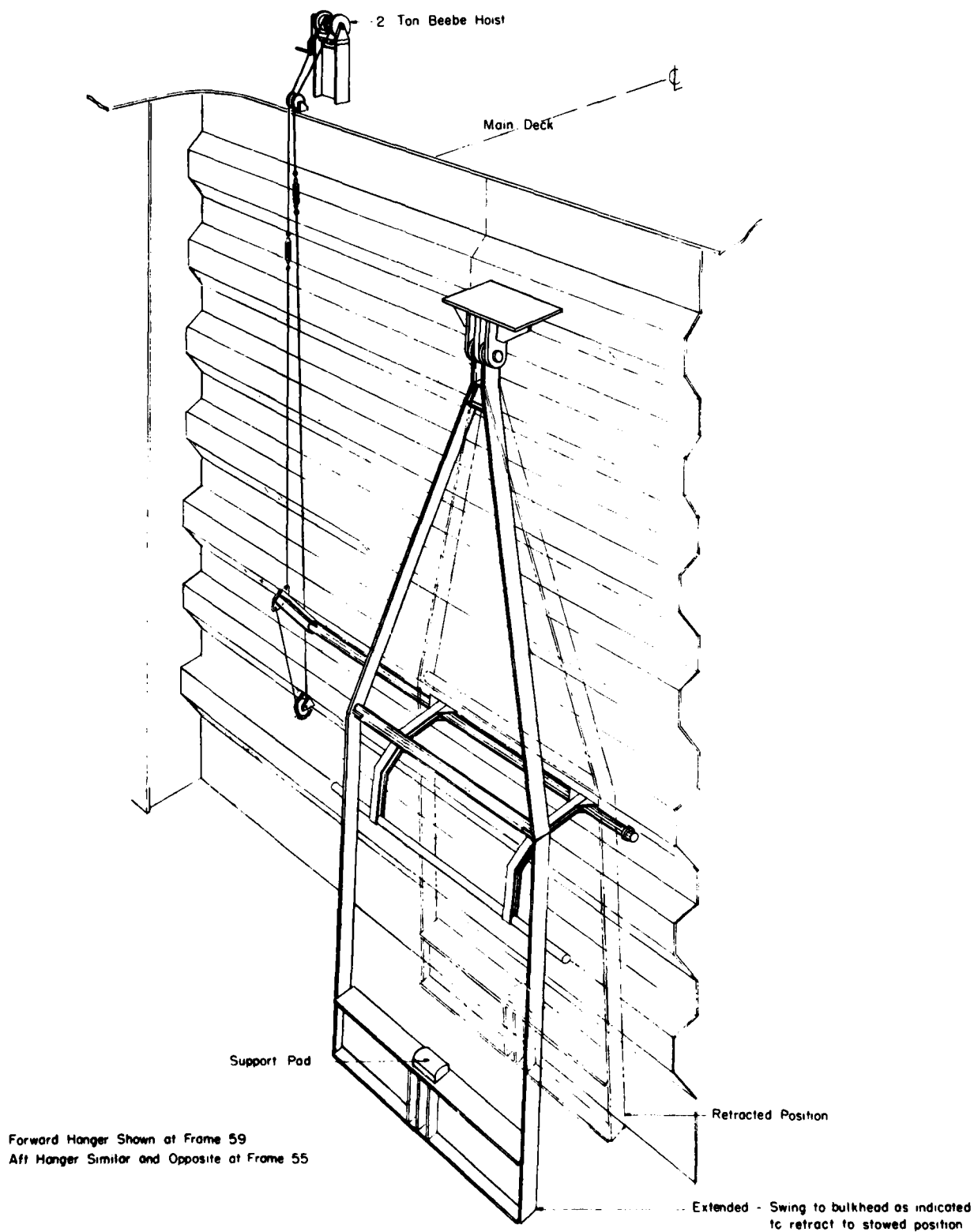


Fig. V-5 - Array support hangers

V-B-10-e Lock stabilizers out by turning forward hand-wheel clockwise and after handwheel counter-clockwise until locks hit stops, or one-half turn.

V-C TO LOWER ARRAY STRUCTURE FOR INSTALLATION OF ROPE GUIDE SLEEVES

V-C-1 Notify cable room observers before commencing to lower structure and notify array winch observers to lock out pawls.

NOTE: When raising and lowering structure in well, keep alert watch on tension recorder. At any sudden rise in tension, stop all operations immediately as structure may be binding.

V-C-2 Lower array structure two feet per minute approximately 21 feet following array travel with electric cable reels set on speed control.

V-C-2-a Officer on Deck shall notify supervisor in control room if structure is level at all times. Station one seaman forward and one aft to prevent shoes from jamming.

V-C-2-b Supervisor shall watch electric cables on port side to direct reel operators to take up excess slack as structure is lowered and supervise hoisting of each wire. When the electric cables are horizontal, reel operators shall notify each cable room observer the amount of slack desired and observer shall keep reel operator informed to the amount of slack on drum. Cable tension indicator will register a small tension at this time.

V-C-2-c Stop lowering structure at 44 feet marked at array well guide. Stop all winches. Maintain three feet of slack on each cable drum.

NOTE: Electric cable winch operator to assist on deck. Array winch operator and winch observers remain on stations in order to adjust level of structure for installing rope guide sleeves.

NOTE: Top beam of array to be three feet above main deck. (Fig. V-6)

CAUTION: MAINTAIN ARRAY LEVEL WITHIN FOUR INCH DESIGNATED LIMITS THROUGHOUT OPERATION BY INSTRUMENTATION AND SIGNAL CHECK WITH ARRAY WELL OBSERVER.

V-C-3 Hold in this position. All controls on "stop".

V-C-4 To Install Rope Guide Sleeves (Fig. V-7)

V-C-4-a Release four rope guide sleeves from tied-off position.

V-C-4-b Swing davit and chain fall in place on live sheaves. On dead sheave hook chain falls on wire strap. Use chain falls to raise sleeves over V-shaped guides. When V section of sleeve is over and in line with V section of guide on structure, lower sleeve in place.

V-C-4-c Bolt sleeves on fore and aft ends of top horizontal array truss, using four 3-1/2 inch by 1-1/8 inch Allen head bolts with nuts and cotter pins.

V-C-4-d Release chain falls from sleeves, swing davit and chain falls on live sheave to stowed position. Remove chain falls from dead sheave.

V-C-4-e Detach pendants from guide sleeves and secure pendants to structure to prevent possible fouling.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD THE ARRAY BE LOWERED UNLESS ROPE GUIDE SLEEVES ARE IN PLACE.

V-D TO LOWER ARRAY STRUCTURE FOR INSTALLATION OF ROLLER PATH GUIDES

V-D-1 Lower array structure two feet per minute to 35 feet mark using top guide shoe as reference point. Footage

TENSION INDICATOR READINGS	
2 MODULES	66,000 POUNDS
10 MODULES	103,000 POUNDS
20 MODULES	135,000 POUNDS

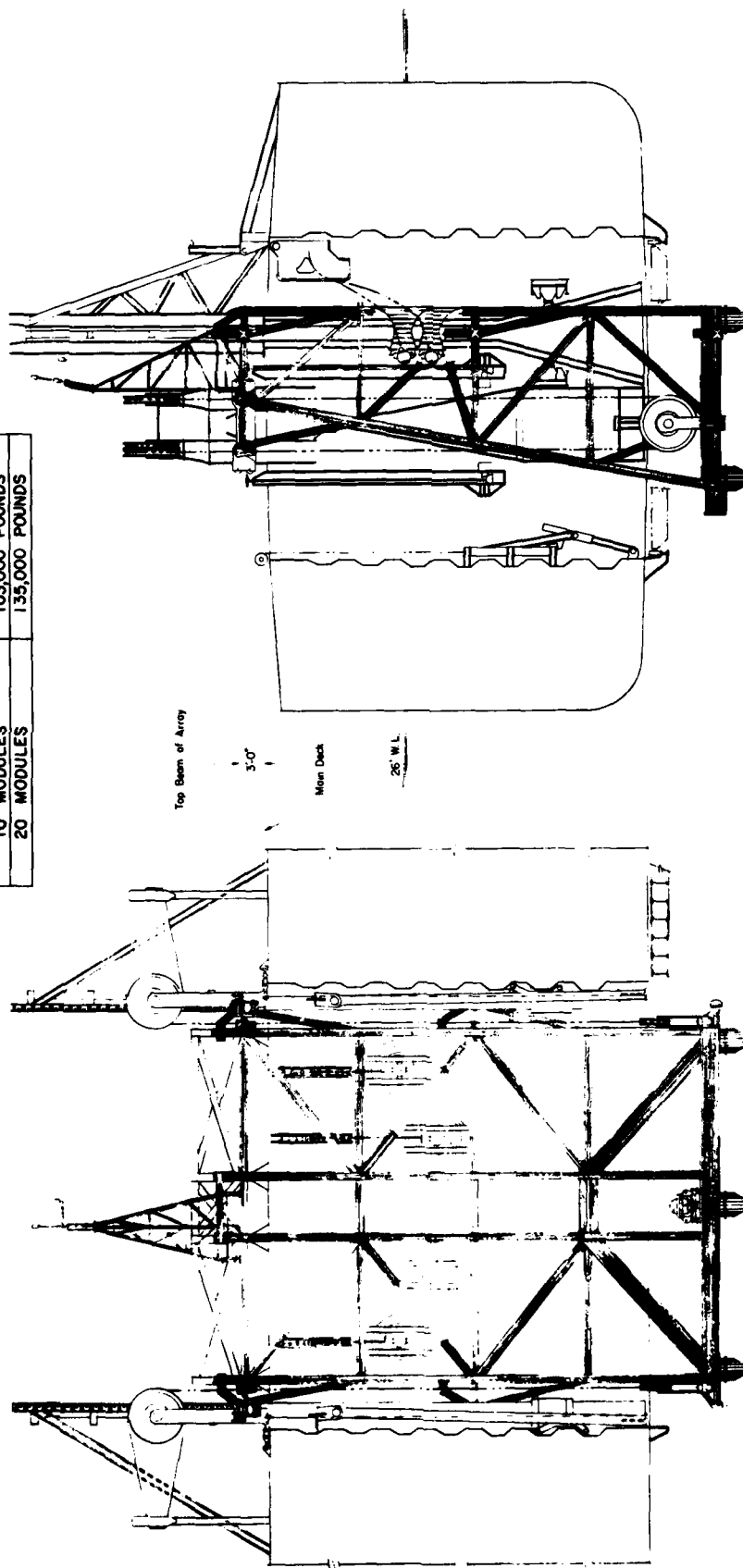


Fig. V-6 - Array in position for installation of rope guide sleeves

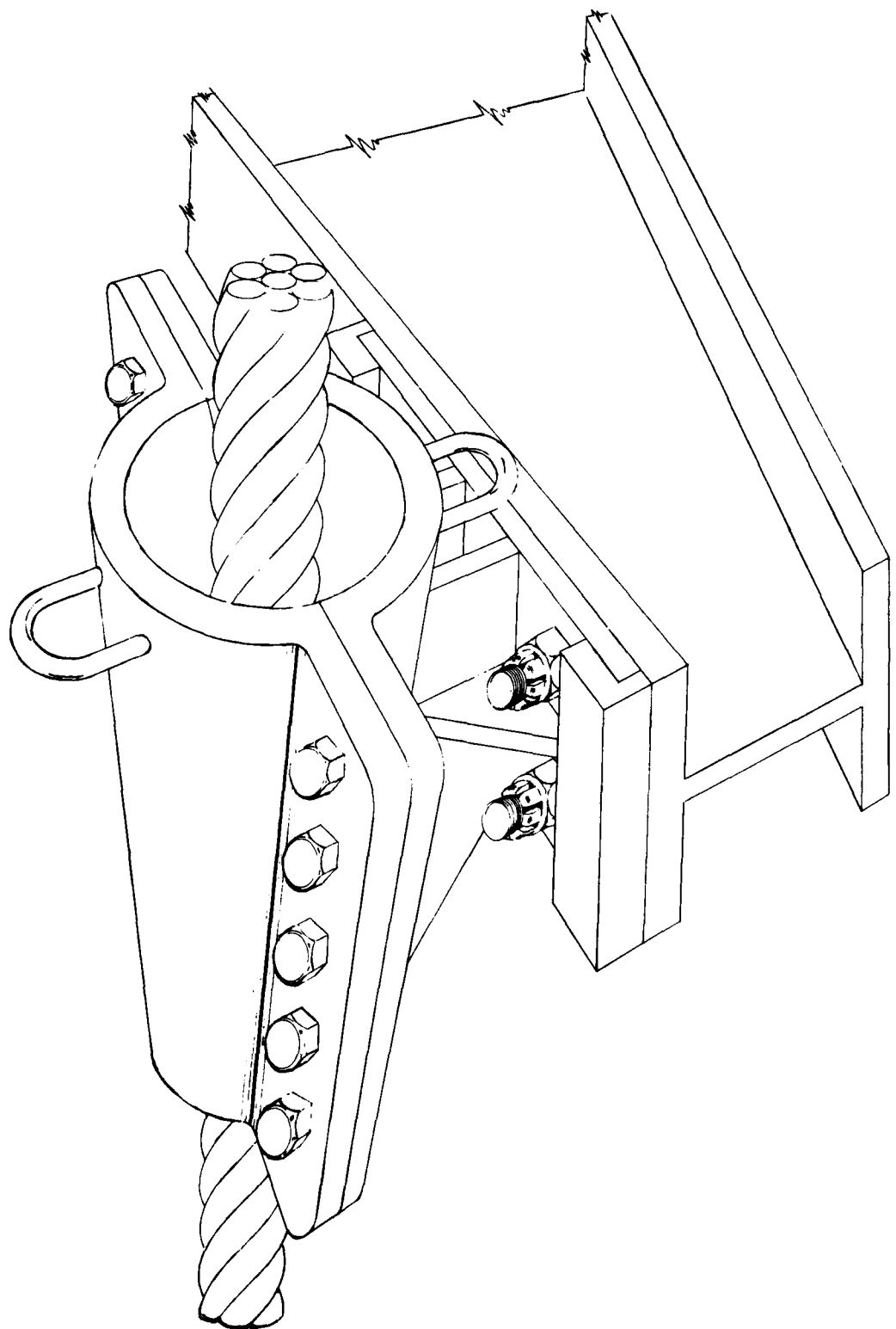


Fig. V-7 - Rope guide sleeve

counter reading 19 feet. Follow array travel with electric cable reels in speed control. Maintain three feet of slack at drum of electric cables.

NOTE: Top beam of array to be five feet below main deck. (Fig. V-8)

- V-D-2 Stop array winch hydraulic motors and electric cable motors.
- V-D-3 To apply roller path guides (Fig. V-9)
 - V-D-3-a Remove retainer wedge while roller path guides are in stowed position, placing full weight of guide on chain. Energize five-ton Beebe hoist and raise guide. When guide is supported by hoist, remove chain hangers from guide.
 - V-D-3-b At this point the roller path guide should be high enough and centered between tracks. Lower guide into tracks. When guide is lowered into tracks the 2-3/4 inch wire will enter guide path.
 - V-D-3-c The roller path guide assembly is equipped with two levers, each extending 15 inches above the top closure plate of the assembly. The levers in stowed position are inclined transversely to center. Move the levers outboard from center to engage the closing roller of each roller path. Insert locking pins provided through the levers and mating pad eyes to secure.
 - V-D-3-d Slowly lower the roller path guide assembly maintaining alignment of track rollers with tracks. Depress the spring loaded scraper below the bottom track roller to clear track.
 - V-D-3-e Repeat V-D-3-a, b, c and d for forward rope roller path guide assembly.
- V-D-4 Lower array structure approximately 24 feet, using slow speed. Follow array travel with electric cable reels paying out as necessary to maintain a slight amount of slack in cables at reel room (paying out at same rate as array is being lowered).

TENSION INDICATOR READINGS	
2 MODULES	66,000 POUNDS
10 MODULES	98,000 POUNDS
20 MODULES	130,000 POUNDS

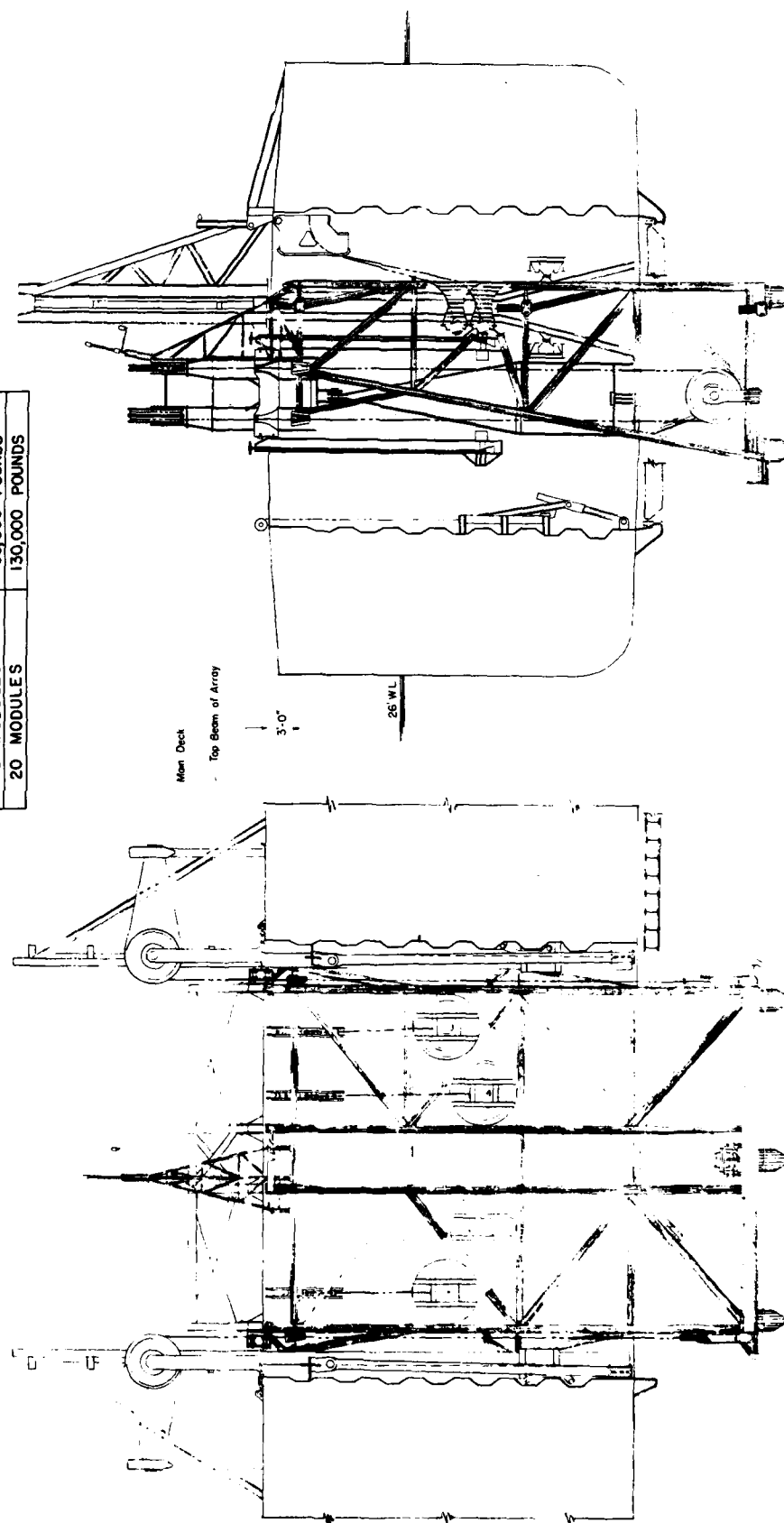


Fig. V-8 - Array in position for installation of rope roller path guides

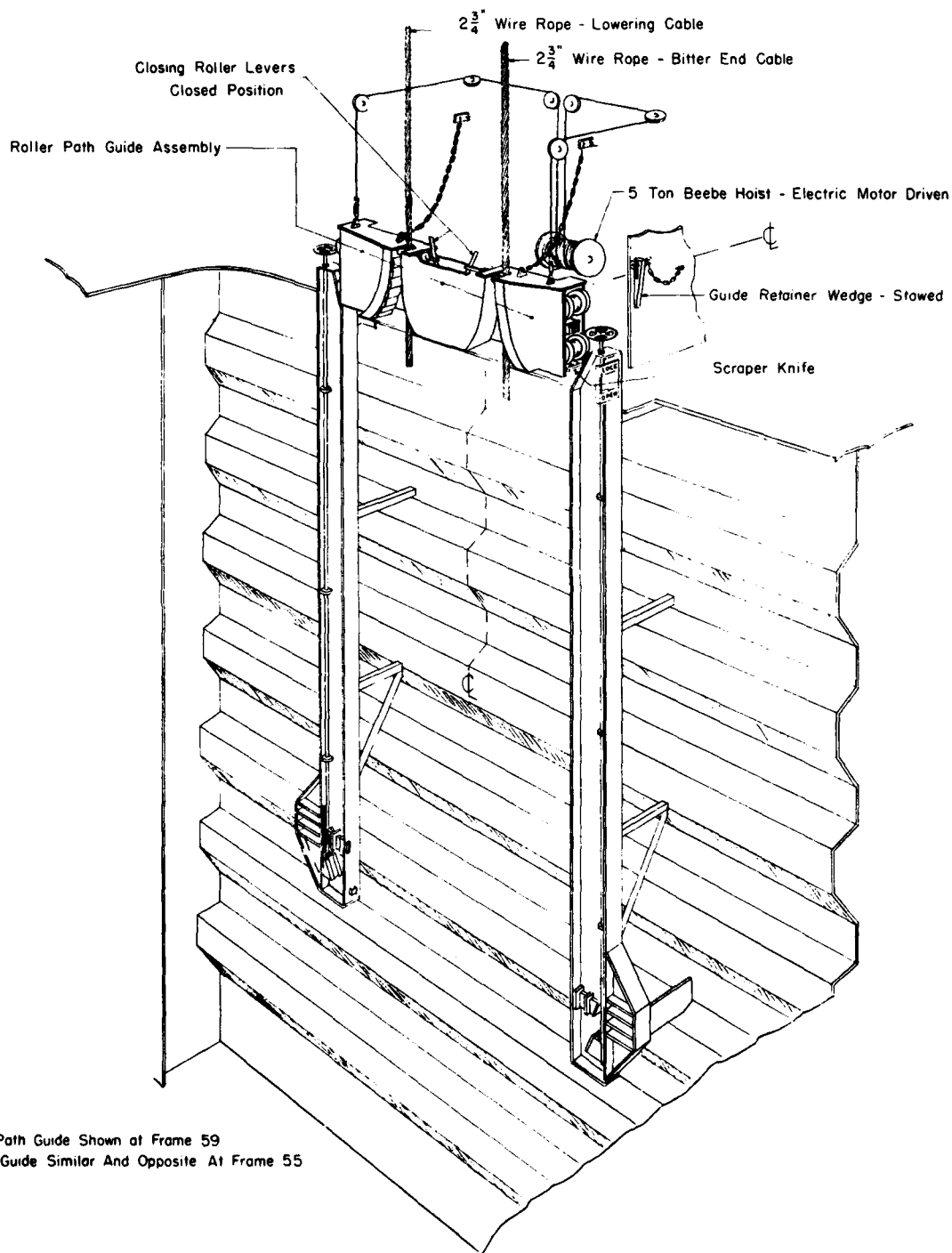


Fig. V-9 - Roller path guide engaging in track

V-D-5 Lower roller path guides simultaneously with lowering array (V-D-4). Stop array winch motors and electric cable reels.

NOTE: Top beam of array to be 29 feet below main deck. Forty-two foot depth on array winch counters. (Fig. V-10)

V-D-6 To lock roller path guides in operating position (Fig. V-11)

V-D-6-a Weight of roller path guides will be borne by stops on guide tracks at 16 foot, zero inch waterline (approximately eight feet below surface of water).

V-D-6-b Using 12 inch handwheels on reach rods extending two feet, four inches through the top of the roller path guide tracks, engage locking wedges for both fore and aft roller path guide assemblies. Left hand rotation pulls the wedges into locked position with approximately 40 turns. A pointer and indicator are provided with each of the four reach rods one foot below each handwheel to indicate locked or unlocked position.

CAUTION: DO NOT LOWER ARRAY FURTHER UNLESS ALL FOUR WEDGES ARE IN LOCKED POSITION. HAVE DIVER INVESTIGATE FOR FOULED CONDITION IF LOCKED POSITION IS NOT ATTAINED.

ARRAY STRUCTURE NOW HAS ALL ROPE GUIDES ATTACHED FOR DESCENT TO OPERATING DEPTH.

V-E TO LOWER ARRAY TO OPERATING DEPTH

V-E-1 Minimum depth: top of upper row forty feet below surface.
Maximum depth: 1200 feet.

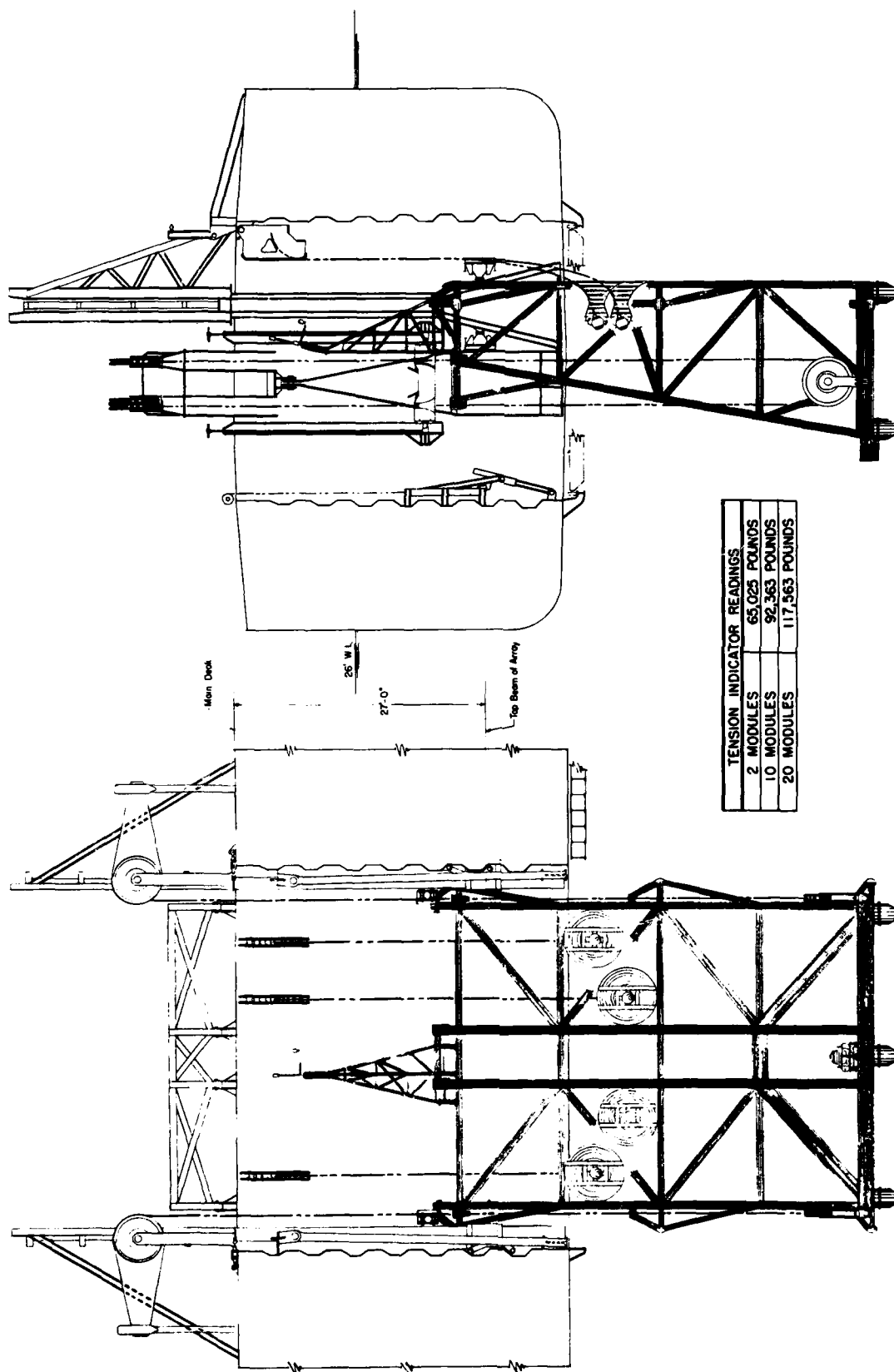
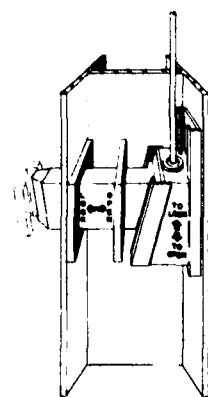
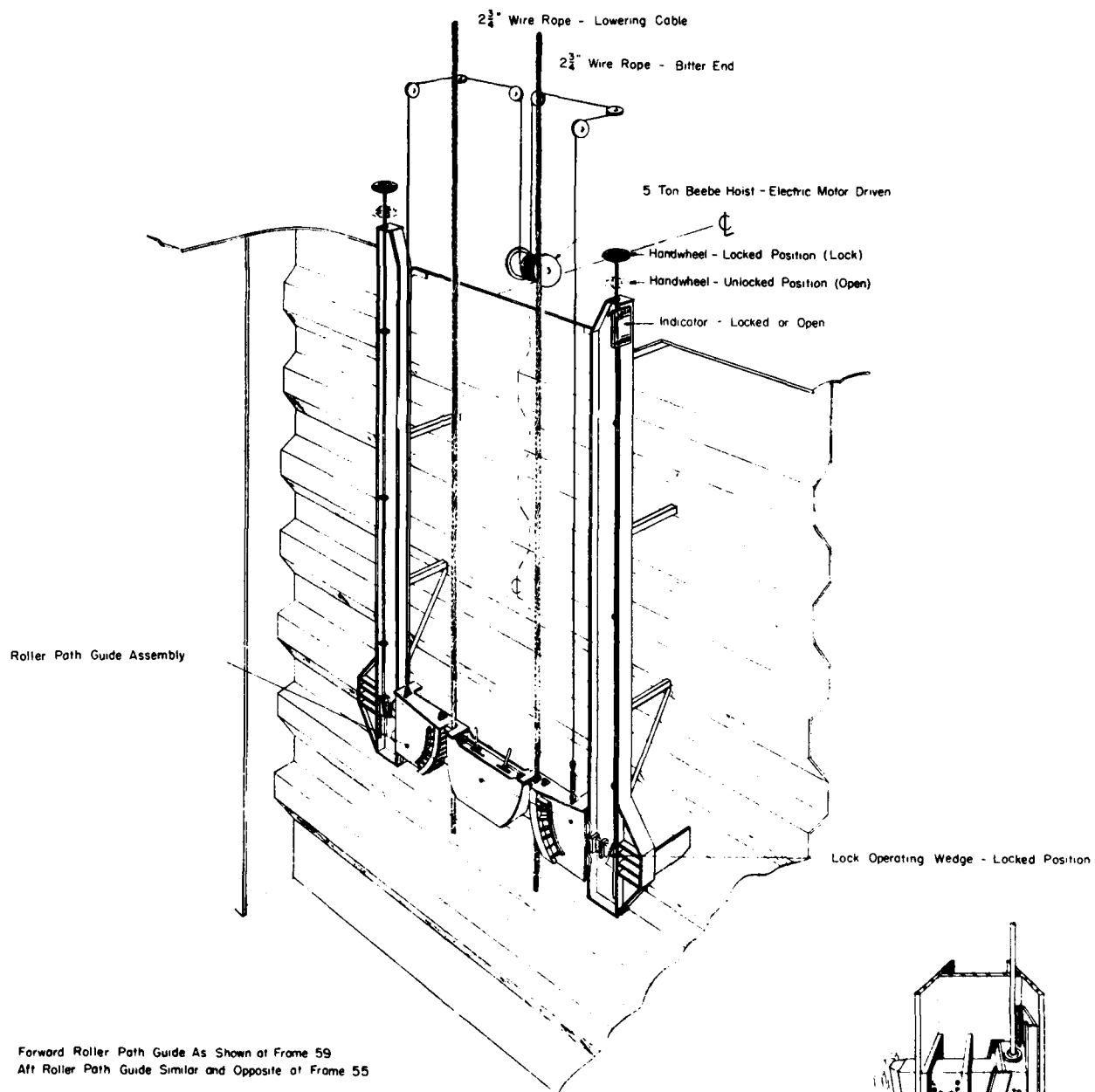


Fig. V-10 - Array in position for locking rope roller path guides



**LOCK OPERATING WEDGE
ARRANGEMENT
ENLARGED**

Fig. V-11 - Roller path guide operating position

V-E-2 Notify personnel in reel room to stand by to lower array, to maintain three feet of slack cable on drums and the lowering speed.

V-E-2-a Commence to lower array at two feet per minute, following array travel with electric cable reels. After array has been lowered 12 feet, the top guide shoes of array structure will be clear of guides.

V-E-2-b Increase speed so that array will clear ship as fast as possible. Continue to lower array until footage counter reads 70 feet on each array winch. Slow array winches and electric cable winches at 74-foot mark on footage counters.

TOP BEAM OF ARRAY STRUCTURE IS NOW 18 FEET BELOW BOTTOM OF SHIP.

V-E-2-c Take close "tension indicator" readings and record differential in readings while array is in known level position.

V-E-2-d Note any discrepancy of cross level with respect to footage counter.

V-E-3 Hydrophone boom lowering. When required, hydrophone boom will be lowered at this position.

V-E-3-a The hydrophone boom is pushed away from the face of the array by the use of a cylinder and piston arrangement. Cylinder is charged from the main deck by a portable 15 pound carbon dioxide bottle. Boom will fall free after it is pushed about 55 degrees from face of array.

V-E-4 Lower array to operation depth using lowering speed up to maximum of 12 feet per minute as desired. Observe precautions listed below for array winch and electric cable reel operation.

V-E-4-a Array winch operation

Tension Indicators

Should maintain uniform differential as recorded in V-E-2.

If readings become erratic, check the following for cause:

- faulty tension indicator
- faulty strain gauges
- frozen sheave

Readings should increase by weight of 2-3/4 inch diameter wire rope per schedule of Table V-3 and Fig. V-12.

Cross Level

Operate winches to hold array within one degree fore and aft cross level reading. (One degree represents ten inches on the array structure.)

Footage Counter

Refer to footage counter for footage and depth.

Cross level readings have priority over footage counter readings. The stretch in wire rope of the forward winch may differ slightly from that of the aft winch.

Depth

Depth reading is expected to lead footage counter readings by 19 feet because of initial setting.

Speed Indicators

Correlate speeds of fore and aft array winches using differential tachometer for adjustment in attaining equal speeds.

NOTE: Speed readings of lowering or hoisting can be correlated with tachometer readings of the array winch motors by use of Table V-2.

Table V-2 - Conversion Table for Array Speed and Line Speed
Versus Hydraulic Motor R.P.M.

Hydraulic Motor R.P.M.	Drum R.P.M.	Number of Wraps on Drum					
		1	2	3	4	5	6
		Line Speed Array Speed	Line Speed Array Speed	Line Speed Array Speed	Line Speed Array Speed	Line Speed Array Speed	Line Speed Array Speed
100	0.0763	1.733 0.867	1.827 0.913	1.922 0.961	2.016 1.008	2.110 1.055	2.204 1.102
200	0.153	3.466 1.733	3.654 1.827	3.844 1.922	4.032 2.016	4.220 2.110	4.408 2.204
300	0.229	5.199 2.599	5.481 2.740	5.766 2.883	6.048 3.024	6.330 3.165	6.612 3.306
400	0.305	6.932 3.466	7.308 3.654	7.688 3.844	8.064 4.032	8.440 4.220	8.816 4.408
500	0.382	8.665 4.332	9.135 4.567	9.610 4.805	10.080 5.040	10.550 5.275	11.020 5.510
600	0.458	10.398 5.199	10.962 5.481	11.532 5.766	12.096 6.048	12.660 6.330	13.224 6.612
700	0.534	12.131 6.065	12.789 6.394	13.454 6.727	14.112 7.056	14.770 7.385	15.428 7.714
800	0.611	13.864 6.932	14.616 7.308	15.376 7.688	16.128 8.064	16.880 8.440	17.632 8.816
900	0.687	15.597 7.798	16.443 8.221	17.298 8.649	18.144 9.072	18.990 9.495	19.836 9.918
1000	0.763	17.330 8.665	18.270 9.135	19.220 9.610	20.160 10.080	21.100 10.550	22.040 11.020
1100	0.840	19.063 9.531	20.097 10.048	21.142 10.571	22.176 11.088	23.210 11.605	24.244 12.122
1200	0.916	20.796 10.398	21.924 10.962	23.064 11.532	24.192 12.096	25.320 12.660	26.448 13.224

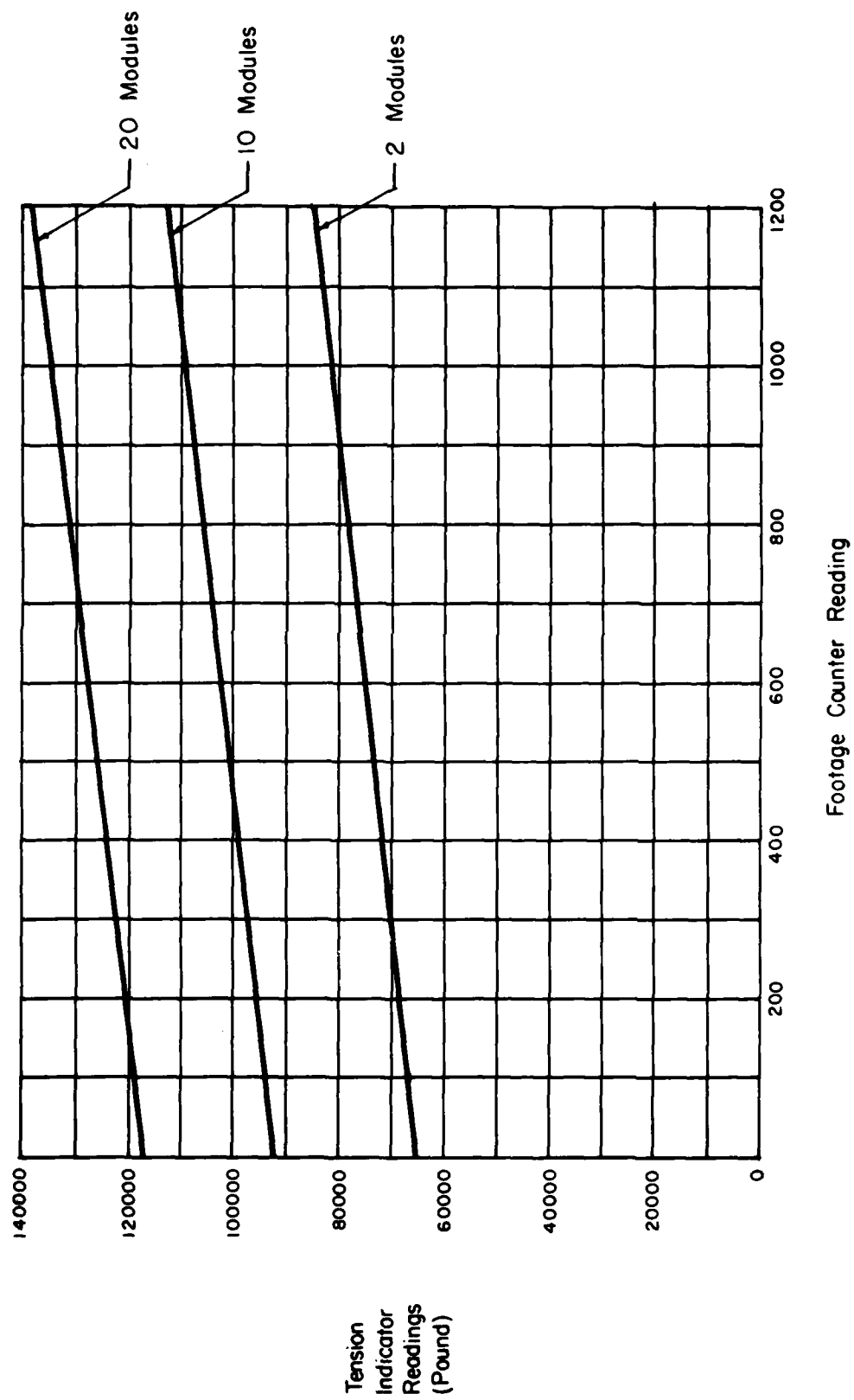


Fig. V-12 - Tension indicator readings at 100-foot increments

Table V-3 - Tension Indicator Readings at 100 Foot Increments

ARRAY DEPTH	2 MODULES	10 MODULES	20 MODULES
100 Feet	66692	94030	119230
200 Feet	68359	95697	120897
300 Feet	70025	97363	122563
400 Feet	71692	99030	124230
500 Feet	73359	100697	125897
600 Feet	75025	102363	127563
700 Feet	76692	104030	129230
800 Feet	78359	105697	130897
900 Feet	80025	107363	132563
1000 Feet	81692	109030	134230
1100 Feet	83359	110697	135897
1200 Feet	85025	112363	137563

V-E-4-b Electric Cable Reel Operation

Extreme care must be exercised in the operation of the electric cable reel controls. Reference is made to Chapter II where a discussion and curves of the tensions to be expected in the electric cables are presented.

It must be emphasized that the cable reels are to be operated in speed control at all times while lowering the array. In order to assure that tension is not placed on the cable attachment at the cable bells, the footage counter for the electric cable should always exceed the value for the array winch.

V-F TO HOLD ARRAY STRUCTURE AT OPERATING LEVEL

V-F-1 Array Winch Operation

V-F-1-a Stop array winch at operating depth.

V-F-1-b Remove lock-out pins on ratchet pawls on fore and aft array winches. Swing pawls into ratchets. Lower array at slow speed to allow load to be taken by pawls. (If cross level indicates in excess of one and one-quarter ($1\frac{1}{4}$) degrees out of level, manipulate either the fore or aft array winch to allow pawl to engage in adjacent ratchet tooth for correction. Ratchet tooth spacing is such that maximum reading of six-tenths (0.6) degrees can be attained.)

V-F-1-c Stop array winch motors.

V-F-2 Electric Cable Reel Operation

V-F-2-a Stop electric cable reels at operating depth.

V-F-2-b Maintain excess of cable to depth as previously discussed in V-E-4-b.

V-F-2-c Stop electric cable reel motors.

V-F-3 Maintain Watch in Array Control Station

V-F-3-a Retain power to tension indicator recorder.

V-F-3-b Record following instrumentation readings at one-half hour intervals, from array winch console:

level
cross level

V-F-3-c Record following instrumentation readings at one-half hour intervals from the three electric cable reel consoles:

tensions at the well

Advise array control station supervisor of noticeable change in attitude or behavior of the array. Maintain electric cable tension indicator at well and excess of cable to depth within limits.

NOTE: If array is held suspended in heavy sea state for extended period, hoist or lower array in increments of five to ten feet on four-hour intervals to move stress concentration points of the 2-3/4 inch diameter wire rope.

CAUTION: RELEASE PAWLS ON ARRAY WINCHES HOISTING SLIGHTLY. FOLLOW PROCEDURES AS SET FORTH IN V-E-4-a AND b AT NEW POSITION.

CHECK WEATHER REPORTS AND ADVISORIES FOR CONDITIONS THAT COULD PRODUCE SHIP MOTION BEYOND OPERATING LIMITATIONS.

V-G TO HOIST ARRAY STRUCTURE FROM OPERATING DEPTH FOR RE-ENTRY INTO ARRAY WELL (Fig. V-13)

CAUTION: CHECK LONGITUDINAL AND ATHWART-SHIP TRIMS OF SHIP. BALLAST TO NEAR ZERO TRIMS IF NECESSARY.

V-G-1 Man all stations. Disengage array winch pawls.

CAUTION: CHECK THAT PAWL LOCKING PIN IS
LOCKED-OUT.

V-G-2 To hoist array to check out position before actual
re-entry

V-G-2-a Array winch operator

Using highest speeds of array winches consistent with maintaining control of array in cross level.

Maintain check between footage counter readings and cross level to verify proper functioning of cross level.

Adhere to instructions as set forth in V-E-4-a.

V-G-2-b Electric cable reel operation

Maintain excess cable to depth within close limits.

Adhere to instructions as set forth in V-E-4-b.

V-G-3 Hoist array to check-out position. Footage counter
reading 74 feet.

NOTE: Top beam of array to be approximately 15 feet
below ship's bottom. (57 feet below main deck)
(Fig. V-13)

V-G-3-a Check tension indicator readings for consistency.
Note any change from readings of V-E-2-c.
Check cross level readings for consistency.
Note any change from readings of V-E-2-c.

CAUTION: IF INCONSISTENCIES OF INSTRUMENTATION
EXIST TO THE EXTENT THAT CROSS
LEVEL IS INDETERMINATE, DISPATCH
DIVER TO MEASURE ACTUAL CONDITION
OF CROSS LEVEL.

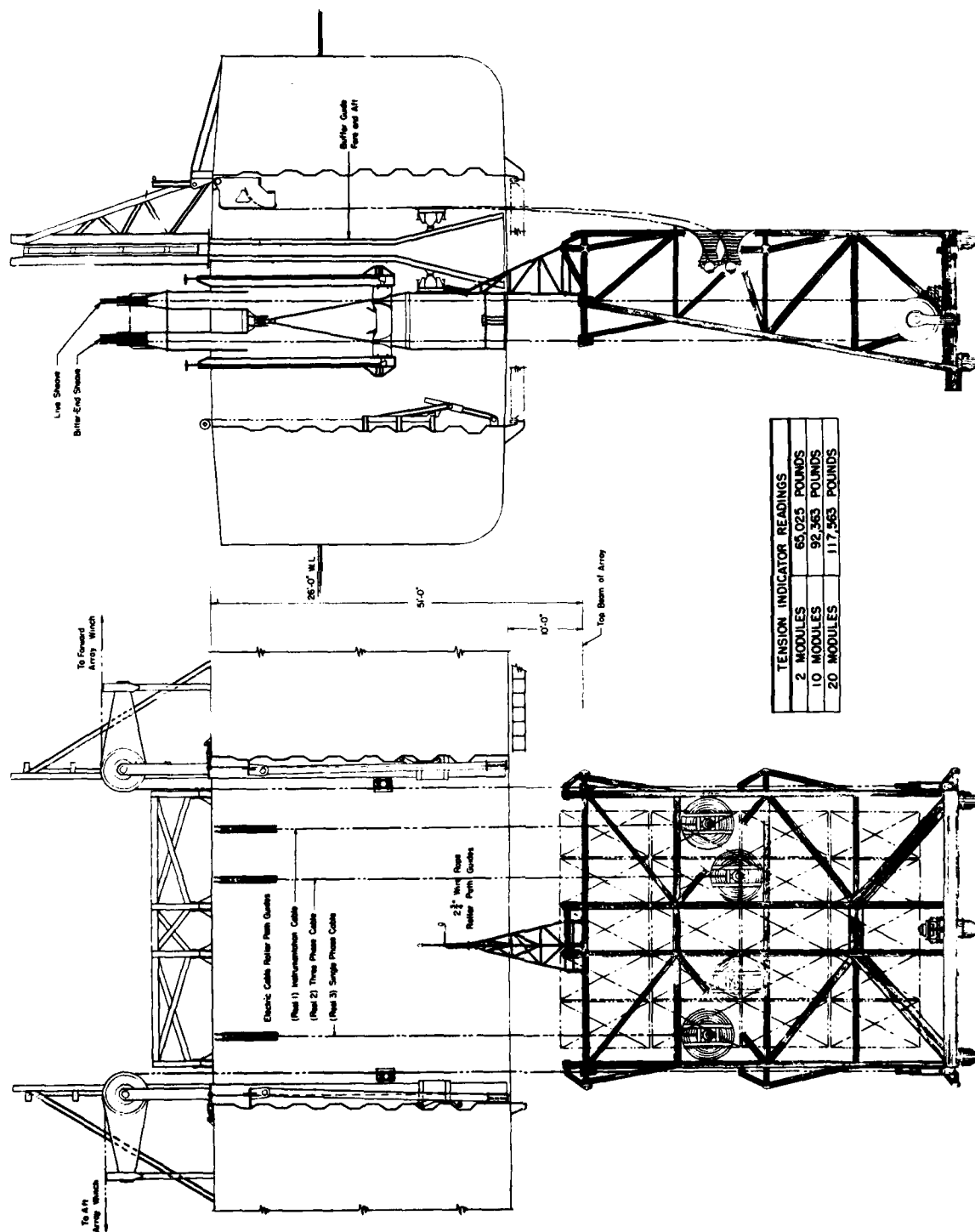


Fig. V-13 - Array in check out position for reentry

V-G-3-b If hydrophone boom is extended, it shall be retrieved at this depth (footage counter reading, 74 feet). Do not raise array beyond this point until hydrophone boom has been retrieved. To retrieve hydrophone boom, remove heaving line from no. 3 electric cable, transfer line for forward starboard well edge on main deck. Haul in on line until line is tight and boom is solid against face of array. Keep all slack out of line while hoisting array. When array surfaces, tie boom to array structure with manila line.

V-H TO HOIST ARRAY STRUCTURE FOR UNLOCKING ROPE ROLLER PATH GUIDES (Stop at 35 feet indicated at array control station)

V-H-1 Hoist array using slow speed approximately 30 feet. Follow array travel with electric cable reels. Maintain two feet of slack at drum in reel room.

NOTE: Top beam of array to be 28 feet below main deck (Fig. V-10).

CAUTION: MAINTAIN CLOSE WATCH ON ARRAY WINCH TENSION INDICATOR. A SHARP INCREASE INDICATES FOULING. IF FOULING OCCURS, DO NOT PROCEED FURTHER UNTIL CONDITION IS CORRECTED. DISPATCH DIVER TO INVESTIGATE IF NECESSARY.

CAUTION: ARRAY CONTROL SUPERVISOR AND OFFICER IN CHARGE AT ARRAY WELL TO KEEP CONTINUOUS CHECK ON ELECTRIC CABLES.

NOTE: The peak fittings of the position determination system on the hydrophone tower will break the surface of the water after approximately 9 to 10 feet travel. Footage counter reading, 55 feet.

V-H-2 Stop array winches and electric cable reels.

V-H-3 Unlock rope roller path guides.

V-H-3-a Apply clockwise rotation to each of the four handwheels at the top of each roller path guide track, two forward and two aft.

V-H-3-b Handwheels will lower approximately 10 inches with 40 turns of the handwheel - full travel.

V-H-3-c Check indicators at outboard of each guide track for "open" position.

V-J TO HOIST ARRAY STRUCTURE FOR REMOVAL OF ROPE ROLLER PATH GUIDES

V-J-1 Hoist array using slow speed. Follow array travel with electric cable reels (Two feet of slack at reel).

V-J-1-a Using Beebe hoist, commence hoisting roller path guides when structure is at 35 feet (on footage counter) keeping roller path guide ahead of structure.

V-J-1-b Hoist array using slow speed through position where top beam of array structure breaks the surface of the water.

CAUTION: MAINTAIN CLOSE WATCH ON ARRAY WINCH TENSION INDICATOR FOR EVIDENCE OF FOULING.

Supervisor to keep visual check on electric cables from platform at array control.

Array well observer to maintain close surveillance of travel through surfacing for level condition.

NOTE: Top beam of array should surface with footage counter reading at 29 feet. Alert array well observer.

CAUTION: IF LEVEL CONDITIONS AT ARRAY WELL AND BY INSTRUMENTATION DO NOT CORRELATE, STOP HOISTING AND CORRECT LEVEL AS REQUIRED.

V-J-1-c Hoist array using slow speed approximately 12 feet.

Supervisor to keep visual check on electric cables from platform at array control.

NOTE: Top beam of array to be three feet below main deck (Fig. V-8). Footage counter reading of 17 feet.

CAUTION: ARRAY WINCH TENSION INDICATOR WILL INCREASE GRADUALLY AS BUOYANCY EFFECT OF ARRAY IS DIMINISHING. SHARP INCREASES INDICATE FOULING. MAINTAIN ARRAY LEVEL.

V-J-1-d Stop array winches and electric cable reels.

V-J-2 To Remove Roller Path Guides

V-J-2-a Using five ton Beebe hoist located on main deck between array sheave supports, hoist forward and after roller path guides to 44 foot mark on orientation markings.

V-J-2-b Remove locking pins on levers that actuate rollers for locking 2-3/4 inch wire rope in roller path guides. Move levers inboard, unlocking 2-3/4 inch wire rope.

V-J-2-c Secure chain supports on array sheave support structure to roller path guides.

V-J-2-d Lower roller path guides using Beebe hoist until guides are in place against array sheave support structure. Insert wedges and keeper bolts for securing.

V-K TO HOIST ARRAY STRUCTURE FOR REMOVAL OF ROPE GUIDE SLEEVES

V-K-1 Hoist array using slow speed, seven feet. Follow array travel with electric cable reels. Supervisor to keep visual check on electric cables from platform at array control.

NOTE: Top beam of array to be four feet above main deck. (Fig. V-6) Footage counter reading at ten feet.

CAUTION: ARRAY WINCH TENSION INDICATOR WILL CONTINUE TO INCREASE GRADUALLY AS BUOYANT EFFECT OF ARRAY IS DIMINISHING. SHARP INCREASES INDICATE FOULING. MAINTAIN ARRAY LEVEL.

V-K-2 Stop array winches. Stop electric cable reels.

V-K-3 To remove rope guide sleeves

V-K-3-a Swing davit and chain fall in place on live sheave. On dead sheave hook chain fall on wire strap.

V-K-3-b Attach pendants provided to each of four rope guide sleeves.

V-K-3-c Remove four 1-1/8 inch by 3-1/2 inch Allen head bolts from rope guide sleeves and array structure.

V-K-3-d Take strain on chain falls and lift rope guide sleeves free of array structure.

CAUTION: NO PORTION OF ROPE GUIDE SLEEVE ASSEMBLIES CAN REMAIN ON ARRAY STRUCTURE. FOULING IN 2-3/4 INCH DIAMETER WIRE ROPE SHEAVES WOULD OCCUR. SECURE ROPE GUIDE SLEEVES FROM UPWARD MOVEMENT BY TYING TO DECK STRUCTURE WITH MANILA ROPE.

V-L TO HOIST ARRAY STRUCTURE FOR STOWING

- V-L-1 Hoist array structure 21 feet, six inches, using slow speed. Follow array travel with electric cable reels in speed control maintaining slack.

NOTE: Top beam of array to be 25 feet, six inches above main deck. Align arrow on top array guide shoe with draft reading 65 feet, six inches. Footage counter reading at 11.5 feet (99987.5). Electric cable reels to operate in speed control.

CAUTION: TENSION INDICATOR AT WELL OF ELECTRIC CABLES PASS OUT OF OPERATING RANGE DURING TRAVEL. DO NOT USE TENSION INDICATOR AT WELL READINGS.

- V-L-2 Stop array winches. Stop electric cable reels.

V-L-3 To Place Lower Stabilizer Struts in Place

- V-L-3-a Structure must be raised to 65 feet, six inches, using upper guide shoe for reference point. Footage counter reading of 11.5 feet (99987.5).

- V-L-3-b Engage hand cranks in winches (see V-B-10). Take strain on cable disengage locking pawls. Take strain on hand brake. Remove hand crank and stow.

- V-L-3-c To unlock and lower forward and after lower stabilizers, turn forward locking bar hand-wheel counterclockwise and the after hand-wheel clockwise one-half turn or until locking bar hits stops. Ease off on hand brake. Lower gently until wire rope becomes slack.

- V-L-3-d Lock stabilizers in by turning forward hand-wheel clockwise and after handwheel counterclockwise until locking bar hits stops.

V-L-4 To Place Upper Stabilizer Strut in Place

- V-L-4-a Lower array structure to 60 feet, using upper guide shoe for reference point. Footage counter reading of six feet (99994.0).

V-L-4-b Take wire rope for hoisting stabilizer strut and feed through fairlead sheave to forward gypsy head on tagline winch.

V-L-4-c Start tagline winch. Take strain on wire rope. Remove turnbuckles and lower away until it comes to rest on stops. Insert toggle pins in struts and stops.

V-L-5 To Swing Support Hangers into Operating Position

V-L-5-a Lower array to 56 feet, four inches, using upper guide shoe for reference. Top beam of array to be 16 feet, four inches above main deck. Footage counter to be 2.2 feet (99997.8).

V-L-5-b Engage hand crank on each two-ton Beebe hoist, one forward and one aft of array well near port bulkhead. Release holding dog.

V-L-5-c Clockwise rotation of the hand cranks extend the support hangers. Extend to full travel evidenced by winch effort reaching stop.

V-L-5-d Set holding dog in ratchet of two-ton Beebe hoist.

V-L-6 To Lower Array to Stowed Position

V-L-6-a Lower array, using slow speed, approximately two feet. Follow array travel as set forth in V-K-1.

NOTE: Top beam of array to be 16 feet, two inches above main deck. Footage counter reading of 2.2 feet (99997.8).

Align arrow on top array guide shoe with array on fixed guide at 54 feet, two inches on draft reading. Footage counter reading of 00000.

CAUTION: CHECK REFERENCE MARKS CLOSELY.
IF TENSION INDICATOR READINGS DO NOT

DECREASE WHEN ARRAY HAS EXCEEDED TRAVEL AS INDICATED BY REFERENCE MARKS BY ONE INCH, DO NOT LOWER FURTHER. DISPATCH DIVER TO MAKE ACCURATE CHECK ON ALIGNMENT OF SUPPORT HANGERS WITH RESPECT TO BOTTOM BEARING PADS OF ARRAY.

DO NOT ALLOW TENSION INDICATOR TO DROP BELOW 30,000 POUNDS. (TENSION INDICATOR SHOULD READ 30,000 POUNDS MINIMUM, 50,000 MAXIMUM, IN STOWED POSITION.)

- V-L-6-b Stop array winches. Stop electric cable reel.
- V-L-6-c Start electric cable reels and put three feet of slack at each cable drum. When three feet of slack is obtained, stop electric cable reels.
- V-L-6-d Release fore and aft array winch pawls from locked-out position and swing into engagement with ratchet.

NOTE: Load will probably not be taken by the pawls because of spacing of ratchet teeth. Allow load to be supported by the winch brakes.

V-L-7 To Close Bottom Door

- V-L-7-a Start tagline winch. Secure drums and drum clutches. Use aft gypsy for pulling door closed. Use forward gypsy for snubbing.
- V-L-7-b Check all operating cable for possibility of fouling.
- V-L-7-c Withdraw locking pins. Handwheels (2) located port and starboard at forward corners of array well. Apply tension on snub line to keep door against forward stops. Use full length of withdrawal screw, approximately 88 turns for 22 inch travel. (If locking pin does not pull using handwheel leverage only, additional power to the screw for a maximum

torque of 400 foot pounds is permissible. Reciprocating action produced by alternate pulls on the line on the fore and aft gypsy spools will aid in releasing locking pins.)

V-L-7-d Pull door closed using aft gypsy. Pay off snub line on forward gypsy.

The position of the yokes in the tracks running fore and aft can be used to ascertain the approximate position of the door.

NOTE: If fouling occurs, dispatch diver with fire hose to wash away fouling materials on door roller tracks.

V-L-7-e With door against aft stops, release tension on forward gypsy snub line and maintain tension on aft gypsy line to hold door against aft stops.

V-L-7-f Extend locking pins to full travel. Release tension on forward gypsy and secure tagline winch. Alternate pulls on the lines may be necessary to allow pins to reach full travel; 88 turns for 22 inches.

V-L-7-g Stow operating cable.

V-M TO HOIST ARRAY STRUCTURE TO MAINTENANCE POSITION

V-M-1 Open bottom door. Follow procedure set forth in Section V-A-1.

V-M-2 Unlock and stow upper stabilizing strut. Follow procedure set forth in Section V-B-9.

V-M-3 Unlock and stow lower stabilizing struts. Follow procedure set forth in Section V-B-10.

V-M-4 Pull pawls on fore and aft array winches and insert pawl lock-out pins.

V-M-5 Hoist array structure from stowed position. Follow procedure set forth in Section V-B.

V-M-6 Retract support hangers. Follow procedure set forth in Section V-B-8.

V-M-7 Hoist array, using slow speed, to desired height for maintenance. Follow array travel with electric cable reels in speed control.

CAUTION: DO NOT HOIST ABOVE MAXIMUM HEIGHT. TOP FLANGE OF ARRAY STRUCTURE BASE (24-INCH BEAM) IS FLUSH WITH THE MAIN DECK AT MAXIMUM HEIGHT. (FIG. V-14)

NOTE: Electric cable reels to operate in speed control. Maintain three feet of slack in electric cables.

CAUTION: MAXIMUM ARRAY TENSION INDICATOR READINGS ARE ATTAINED DURING THIS OPERATION. SHARP INCREASES INDICATE FOULING. MAINTAIN ARRAY LEVEL.

V-M-9 To Hold Array at Desired Height for Maintenance

V-M-9-a Stop array winches. Stop electric cable reels.

V-M-9-b Remove lock-out pins on fore and aft array winch pawls and swing pawls to engagement with ratchet.

V-M-9-c Lower array at slow speed to allow load to be taken by pawl.

NOTE: Check position of pawls on fore and aft array winches for ratchet tooth position that will bear load with minimum out-of-level condition.

V-N TO LOWER ARRAY FROM MAINTENANCE POSITION TO STOWING POSITION

V-N-1 Establish communications with personnel in reel room and at array winches. Check and determine if all personnel are on station and ready to commence array operation. Contact engine room and request that power

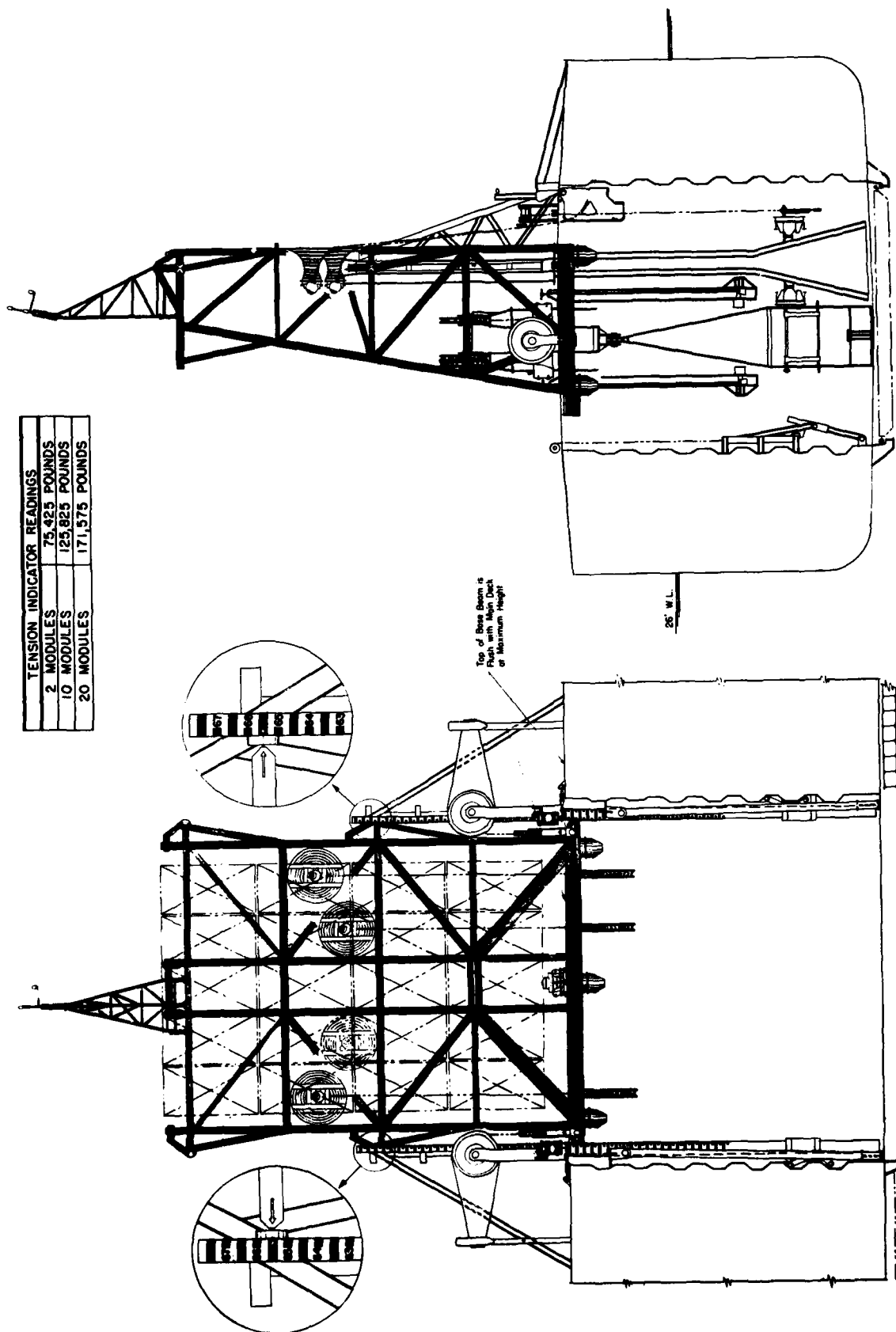


Fig. V-14 - Array at maximum height for maintenance

be supplied to array winches and Varepack. When notified power on to winches and Varepack, start array winch motors and electric cable reel motors.

- V-N-2 Lower lower stabilizer struts in place as discussed in Section V-L-3.
- V-N-3 Hoist array approximately three inches. Pull pawls from engagement with ratchet at forward and after array winches. Insert pawl lock-out pins.
- V-N-4 Lower array five feet, nine inches, using slow speed to 60-foot mark on fixed guide, using top guide shoe as reference point.

NOTE: Electric cable reels to operate in speed control. Array supervisor to observe electric cables, not allowing excessive slack to develop in cables. If slack appears, direct reel operator to increase speed of affected cable.

- V-N-5 Stop array winches. Stop electric cable reels.
- V-N-6 Lower upper stabilizer strut as described in Section V-L-4.
- V-N-7 Lower array three feet, eight inches, to the 56-foot, four-inch mark on fixed guide using top guide shoe as reference point, complying with note as shown in Section V-N-4.
- V-N-8 Swing hangers in position as described in V-L-5.
- V-N-9 Lower array, using slow speed, approximately six inches to the 55-foot, 10-inch mark on fixed guide, using top guide shoe as reference point.

NOTE: Comply with Section V-L-6.

CHAPTER VI

MAINTENANCE

In general, maintenance of the array handling equipment is included in the instruction or operation manuals furnished with the various equipment items. The observers, as listed in Chapter IV, will have the responsibility of maintaining those components within the area of their stations.

The instruction on maintenance, as set forth in this chapter, confines itself to those components that extend beyond the scope of a particular area; namely, the array winch wire ropes, the electric cables, and those items that are used in guiding the ropes and cables during the operation.

VI-A INSTALLATION, LUBRICATION, INSPECTION AND CUT-OFF SCHEDULE OF 2-3/4 INCH DIAMETER ARRAY WINCH WIRE ROPE

VI-A-1 Installation

VI-A-1-a Description of rope

The array winch ropes are 2-3/4 inch diameter, six by 55 construction extra improved plow-steel regular lay with seven by 19 IWRC (independent wire rope core), preformed with minimum breaking strength of 350 tons per Federal Specifications RR-R-571a as modified in the contract #N-205-9737. Each rope is 3100 feet long. Lubricant is applied hot during fabrication of the strands and IWRC.

VI-A-1-b To transfer rope from storage reel to array winch drum

Set the manufacturer's storage reel on the deck between frames 65 and 66 for the forward array winch and on frame 52 for the aft array winch. Provide axle and supports of sufficient height to clear the storage reel flanges and line the reels up with their respective array winches with the rope feeding from the top of the storage reel to the top of array winch drum. Secure the free end to the dead line anchor provided in the array winch drum. Wind the

wire rope from the storage reel to the array winch drum using array winch power. Remove the storage reel from the ship.

VI-A-1-c To attach bitter-end socket to 2-3/4 inch wire rope

Apply serving band to rope at a distance from the end of the rope to allow the ends of the wire to be at the top of the socket basket. No wires should protrude above the socket basket, and none should be more than 1/8 to 1/4 inch below the top of the socket basket.

Individual strands are to be broomed out for the full length of the rope end to a point where loss of lay in the strands will not be noticeable outside the socket basket.

Clean the broomed-out end in white (non-leaded) gasoline. Soak the broomed-out ends in gasoline and brush away all grease and dirt, making sure to clean all the way to the bottom close to the serving band.

CAUTION: USE ALL SAFETY PRECAUTIONS WHEN HANDLING THIS FLAMMABLE AND EXPLOSIVE FLUID.

After cleaning, hold the broomed-out ends upright and dry same using compressed air until all gasoline has been evaporated from the wires as well as from the rope under the serving band.

Dip cleaned ends in undiluted muriatic acid (standard 20° Baume) to within 3/4 inch of the serving band for a period of from one to three minutes. Remove grease or dirt that accumulates on the surface of the acid by skimming with heavy paper or burlap.

Rinse broomed-out ends in a hot solution of bicarbonate of soda with concentration of four ounces by weight of bicarbonate of soda to one gallon of water.

Dip broomed-out ends in zinc-ammonium chloride flux. Use hot solution at a concentration of one pound of zinc-ammonium chloride to one gallon of water. Dry thoroughly using compressed air.

Close ends and put in socket. Socket should be heated sufficiently to prevent cold and dampness from causing spelter to blow up during pouring. Distribute wires evenly in the basket so that spelter can surround every wire. Provide sufficient height to the socket in the vertical position to allow proper alignment of the rope with the socket.

Pour the spelter. Spelter is to be Specification ASTM designation B6-49 grade (1) high grade. Pouring temperature is to be 975 degrees Fahrenheit. Remove all dross before pouring. If possible, the spelter should be poured in one continuous pour up to the top of the socket basket so that all wire ends are covered. There should be no "capping" of the socket.

When the socket has cooled, remove the serving band and apply rust preventative or grease to the rope at the base of the socket and any other portion that has had the grease removed during the socketing operation. Apply rust preventative to the socket.

VI-A-1-d To transfer rope from array winch drum to spooling reel (Fig. VI-1)

Set spooling reel on one of the foundations provided for installation of rope on its respective array winch drum. Using the five horsepower drive provided, spool each end drum section of the spooling reel with 1-1/4 inch wire rope. Pass 1-1/4 inch wire rope through dynamometer blocks and fairleads as illustrated. Secure the ends of the rope to their respective LST stern anchor winches at frame 60. Secure 2-3/4 inch bitter-end socket

at anchor provided on spooling reel. Spool line onto LST winches and follow with array winch, maintaining tension on the 2-3/4 inch wire rope of 2000 to 4000 pounds. (Use snubbing blocks and tackle to accomplish relatively spooling if necessary.) Transfer all 2-3/4 inch line to the spooling reel and check rope anchor at array winch drum for being tight.

VI-A-1-e To transfer rope from spooling reel to array winch drum

Use LST winch automatic tension controls to maintain 30,000 pound tension on 2-3/4 inch rope.

CAUTION: DO NOT ALLOW ROPE TENSION TO BECOME LESS THAN 20,000 POUNDS.

Use snubbing blocks and tackle to attain snugness in adjacent wraps on first layer of array winch drum. Assist level spooling with snubbing blocks and tackle on subsequent layers if necessary.

Reeve all 2-3/4 inch rope onto array winch drum. Remove spooling reel.

VI-A-1-f To reeve 2-3/4 inch wire rope to array structure supporting sheaves

Connect tagline to bitter-end connection and pull line off array winch for reeving over live sheave at array well, through the yoke-mounted sheave on the array and two wraps over the bitter-end sheave at the array well to the bitter-end connection. Sufficient rope will be pulled off of the array winch to allow the 2-3/4 inch rope to be tied-off during the reeving of the rope over the respective sheaves to the bitter-end. Use LST winch power in tying off 2-3/4 inch line. (Tie-off attachment should be made using manila rope or gripping device that will not produce undue bending or kinks.)

Take up slack using array winch power and following with LST winches to maintain tension.

Remove tie-off device when tension indicator on array winch console in control station reads 20,000 pounds to 40,000 pounds.

NOTE: Installation procedures for 2-3/4 inch line for either the forward or aft array winches are identical with exception to placement of snatch blocks. (Fig. VI-1)

VI-A-2 Lubrication of 2-3/4 inch rope

VI-A-2-a While hoisting array, wire rope shall be washed with fresh water with special applicator provided to cover complete area of wire rope.

VI-A-2-b Applicator to be applied around wire rope at main deck level below live sheave. Fresh water hose from ship's fresh water system to be connected to each applicator.

VI-A-2-c Lubrication of the 2-3/4 inch rope shall take place during the next lowering operation following washing. The lubricant shall be specification MIL-G-18458, which is miscible with the rope lubrication used in the manufacturing procedure. The lubricant can be applied cold and has lubricating as well as corrosion-preventative features.

VI-A-2-d Lubricant to be applied to wire rope with special applicator which clamps around wire rope.

VI-A-2-e Place applicator in position around wire rope at main deck level beneath live sheave forward and aft. Secure in place with wire straps or manila rope.

VI-A-2-f Connect the two lubricating pumps to applicators and air supply.

**Table VI-1 - Array Winch 2-3/4-in. Diameter Wire Rope
Ton Mileage Record**

[illegible]

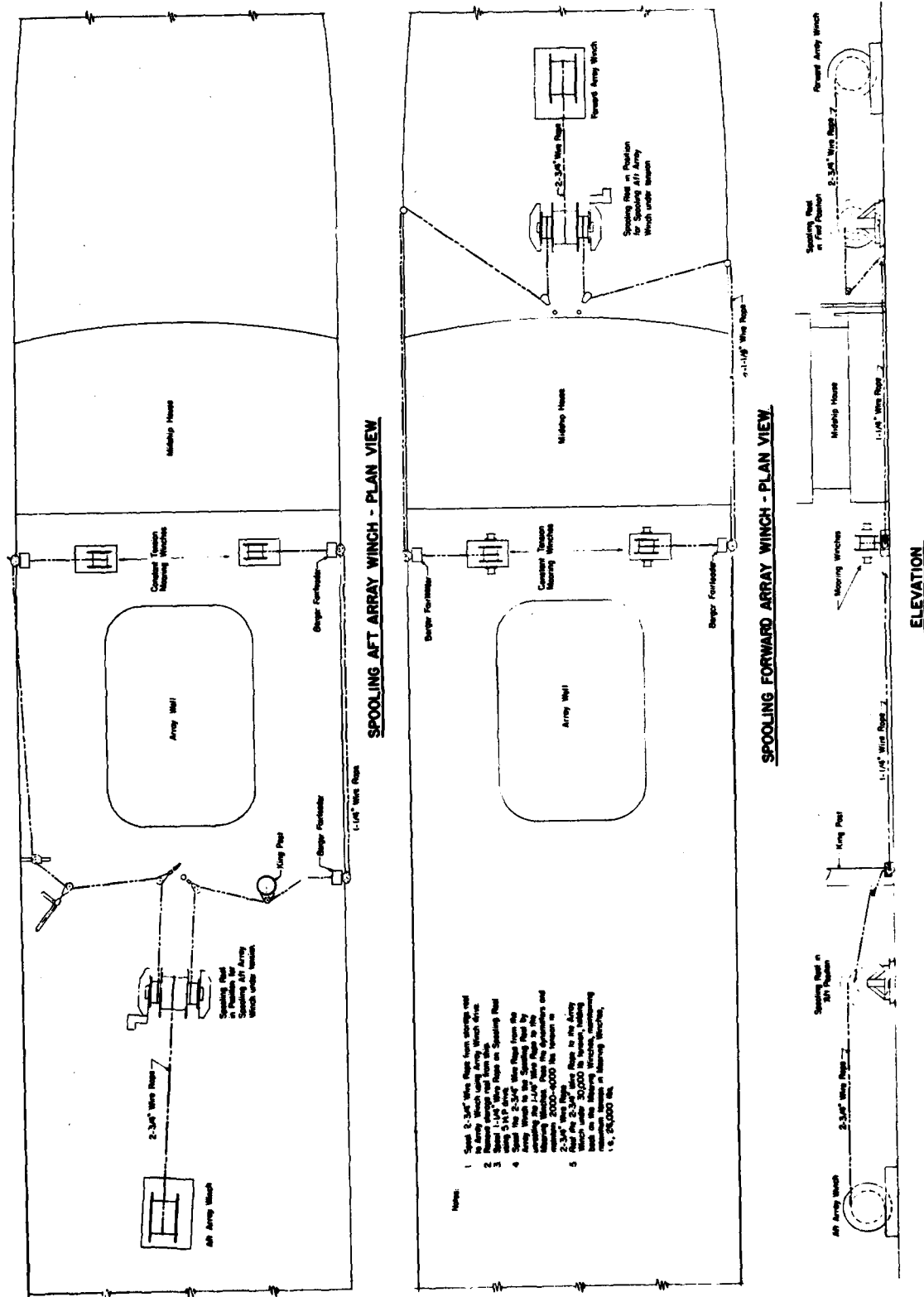


Fig. VI-1 - Arrangement for spooling 2-3/4-in. wire rope under tension

- VI-A-2-g Insert lubricating pump shaft into drum containing proper lubricant. Take necessary precautions to keep lubricant clean and keep all dirt from pump suction.
- VI-A-2-h Commence to lower array.
- VI-A-2-i Open air supply valve and commence lubricating wire rope, regulating air supply as necessary to maintain proper supply of lubricant.
- VI-A-2-j One man will attend each applicator while applying lubricant. At no time will array be lowered while applicator is in place unless it is attended by qualified personnel.
- VI-A-2-k Upon completion of lubrication remove and secure all equipment.
- VI-A-2-l After a hoisting operation, and particularly when the array is in maintenance position, lubricant is to be applied on the bitter-end wraps and the vertical runs in the proximity of the array structure that do not pass over the live sheave.

VI-A-3 Inspection

- VI-A-3-a Inspection of the 2-3/4 inch rope shall take place on a continuing basis during the lowering and raising operation. By such visual inspection, the condition of the rope on the outside can be determined relative to lubrication, surface wear, deformation in a strand, and wire breakage.
- VI-A-3-b Close inspection is to be given to those portions of the rope subjected to the most severe service. These portions are herewith listed:

The portion of rope adjacent to the array winch drum flanges that are subjected to knifing action of the rope by the maximum fleet angle when undergoing change of layer.

The portion of rope that is in contact with the rope roller path guide for an extended period, particularly if sea state produced pronounced rolling of the vessel.

The portion of rope that is in contact with the yoke-mounted sheave in the array for an extended period.

The portion of rope that is in contact with the live sheave for an extended period.

NOTE: During hoisting, two members of the ship are to be assigned to inspection of the array winch wire rope, one forward and one aft. Each man will make the inspection on the array side of the men assigned to the lubrication of the rope as set forth in Section VI-A-2. Damaged portions shall be reported immediately to the Officer on Deck at the array well.

During lowering of the rope as it passes over the live sheave, inspection shall be made from the main deck in the area of the sheave support structure.

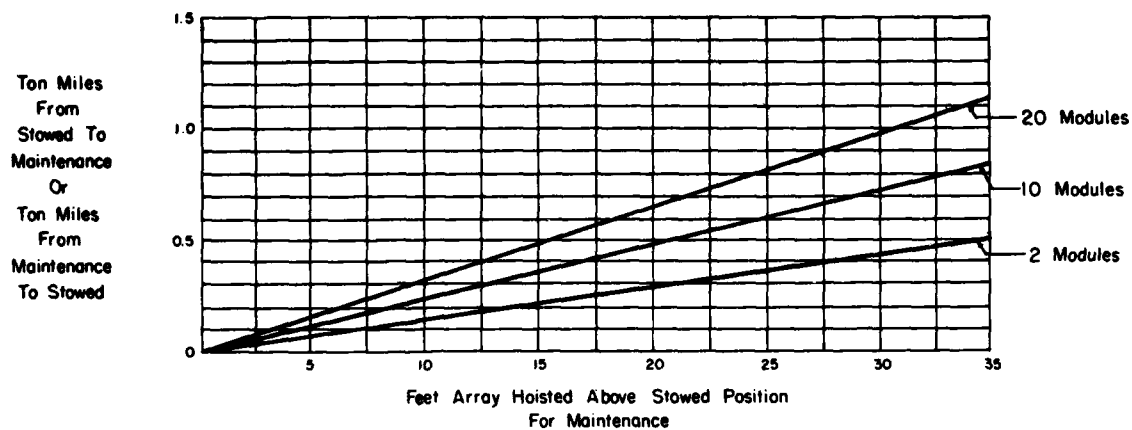
VI-A-4 Recorded Data

VI-A-4-a Ton Mileage Record

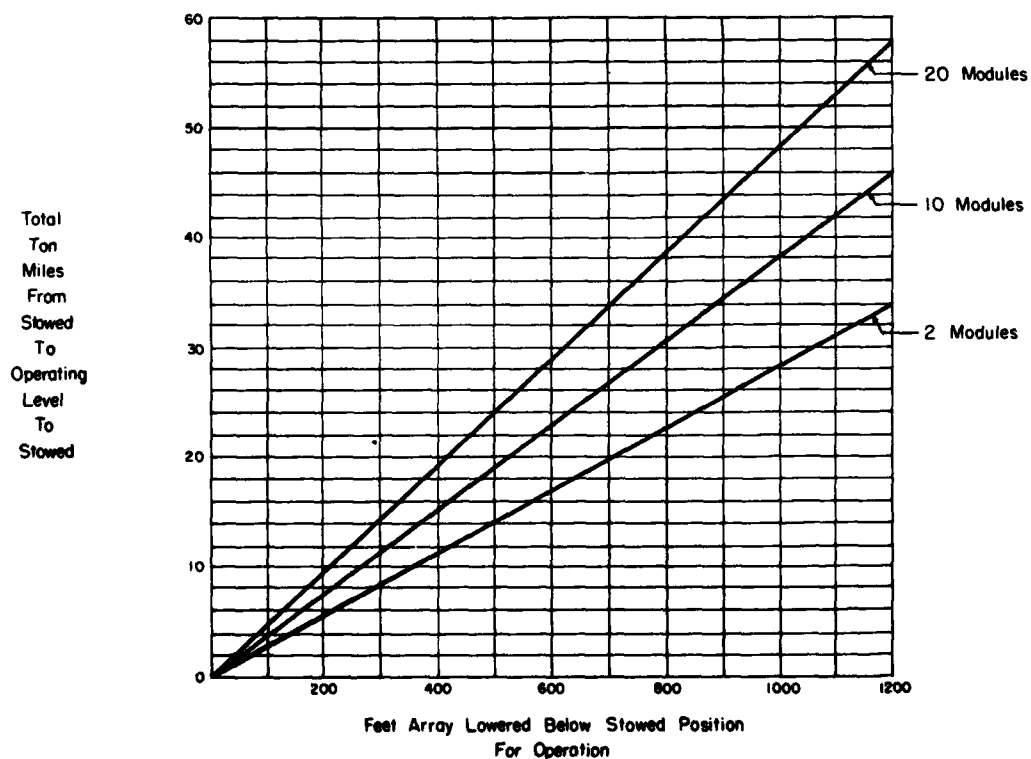
Ton mileage records shall be kept up to date using the data set forth in figure VI-2 and recorded on the form, or a form similar to Table VI-1. Information relative to the ton mileage of each displacement from stowed position either to a maintenance position or to an operation depth is plotted to read directly in ton miles.

VI-A-4-b Individual Wire Breakage

A log shall be kept showing the observed condition of the wire rope, noting specifically the dates of lubrication, condition of lubrication, condition of lubrication, rust and/or scale, individual strand breakage and location



TON MILEAGE CHART MAINTENANCE



TON MILEAGE CHART OPERATION

Fig. VI-2 - Array winch 2-3/4-in. diameter wire rope, ton mileage charts

and condition of the rope at crossover positions on the drum. This report shall be assembled once each month by the ONR Project Representative.

VI-A-5 Cut-Off Schedule

VI-A-5-a If individual wire breakage is detected at the base of the socket or on the innermost or bottom layer of wind on the drum, consideration shall be given to making a cut-off equal to at least 1-1/4 times the circumference of the drum.

VI-A-5-b Wire rope cut-off shall not be made without consultation with the rope supplier.

VI-B INSPECTION AND MAINTENANCE OF THREE ELECTRIC CABLES

VI-B-1 Inspection

VI-B-1-a Each electric cable is double armored to provide the required mechanical strength to support its own weight and to withstand the forces exerted through handling.

VI-B-1-b Normal usage of the electric cables may result in parting of the outer armor wire. Continuous inspection should be made at the side of the well during lowering and raising operations of the armor to detect breakage. If breakage does occur, the armor wire should be layed into position and the end tack welded to the adjacent armor wires. If the broken wire is bent such that it can't be layed in place, the bent and kinked portion shall be cut off as required. The loss of a section of one strand will not adversely affect the strength of the resulting armor.

VI-B-2 Maintenance

VI-B-2-a The armor from the cable bell into the cable trunk is subject to continuous salt spray and

will corrode in a short time. The section, as required, shall be painted at periodic intervals to prevent corrosion of the armor wires.

VI-B-2-b The armor wires shall be preserved using the following procedure.

VI-B-2-b-1 Wire brush armor.

VI-B-2-b-2 Apply pre-treatment primer Mil P-15328B. Use as thin as necessary to get in and under armor. Brush or spray.

VI-B-2-b-3 Paint on thickly the primer Mil P-15929B. This is a shipboard vinyl with red lead pigment. As a substitute, use Mil P-15930A which uses zinc chromate instead of red lead.

NOTE: In general, red lead is used on ferrous surfaces which are not first prepared to bright metal. Zinc chromate is always used on the light metals such as aluminum and can be used on steel where the surface is bright.

VI-B-2-b-4 As a top coating, use Mil L-2638B which is a gasoline and water resistant vinyl resin lacquer. As a substitute, use Mil P-15934A which is a standard vinyl shipboard grey. The Mil L-2638B is preferred.

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|---------------------|--|
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